The Reclamation Era

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The Reclamation Era

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In this issue . . .

J. J. McCARTHY, Editor

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MAN-MADE RAIN

For hundreds of years the American farmer has planted his corn, cotton and spinach and depended on a bountiful nature to keep them watered. All too often nature has let him down. He has been left with scorched fields, withered crops and a note to be renewed at the bank. But the time is approaching when drought-ridden growers will no longer have to depend on rain clouds to spill out their moisture on a thirsty vegetation.

Thousands already are turning on their own rain when they need it and turning it off when they have had enough. It's a new development called portable irrigation, made possible by the invention of aluminum pipe. All the land owner needs in order to get this pushbutton rain when he wants it is a good supply of water, a pump, motor and enough aluminum pipe.

The source of water may be a river, lake, creek, spring or well. Just hook up the pumping system and the aluminum pipe will carry this water to where it ought to be. A set of sprinkler heads will distribute it in a rain-like shower over 1 to 4 acres at a time. Sprinkler heads and pipe are moved as additional acreage is to be refreshed. This form of irrigation is available to every farmer, regardless of how hilly or rough his land may be, if he has a sufficient supply of water around.

"Snooky" Uhlian has a farm bordering the Cumberland River near Nashville. His 90 acres of bottom land has been in the Uhlian family for a half century or more. Snooky is the third generation to sell roasting ears and turnip greens from it. Up to 6 or 7 years ago there were dry years in which the crops were almost a total failure. There have been three successive years of disastrous droughts since then, but not disastrous to Snooky. During those 3 dry years he sold around $20,000 worth of crops a year when most other farmers around him had practically nothing of any kind to offer. The $12,000 he invested in his man-made rainpower 7 years ago more than paid for itself in each of the dry years since. It consists of a pump and motor on the bank of the Cumberland, a few hundred feet of 8-inch main line aluminum pipe, a few more hundred feet of 6-inch lateral pipe, and a volume gun that slings water in a complete 2-acre circle at a setting. He waters about 10 acres each day through the late afternoon and night. His corn retains that healthy dark green color when unirrigated crops roundabout are drying to a crisp.

Someone may ask, why didn't somebody think of this method of watering crops before? Answer: There was no aluminum pipe. The conventional steel pipe was simply too heavy and too expensive to move around over a large acreage for watering an acre or so at a setting. One man easily can pick up a 20-foot length of 6-inch aluminum pipe and walk off with it.

The limiting factor in the use of man-motivated rain is the amount of water available.

One farmer I knew had 200 acres through which a creek flowed. The irrigation dealer who engineered his farm told him he could depend on only enough water to adequately cover 10 acres. So he bought a $2,500 system, put that 10 acres in tobacco, kept it well watered, and made $1,000 an acre. Tobacco, being his chief money crop, always had been about two-thirds his gross income.

by ROSS L. HOLMAN

Another 100-acre farmer who grew 5 acres of tomatoes, cantaloupes, and greens, used the remainder of his 100 acres for dairying. He built an irrigation reservoir. It was replenished by runoff rainy season water from surrounding high ground. He watered only the 5-acre truck patch. He sold $12,000 worth of irrigated tomatoes and cantaloupes the first year at a high price.

The first cost of a portable irrigation system usually runs from $1,000 to $20,000 or more, depending on the amount of acreage to be watered and other factors. These portable outfits are making such a big difference on the farms where they are installed that their use is spreading like measles.

In nearly every State on farms where there is enough water to farm at all, the idea is taking hold. State extension departments are promoting it. In many places it is easier for a farmer to get money from a bank to install portable irrigation than for any other short-term need.

Until recently the only kind of irrigation used to any extent was the flood type. The watered land has to be level and water carried through it by means of canals, furrows, and dikes. It is used on only 3 percent of America's tillable ground. Yet this 3 percent has produced one-fourth of the Nation's products. Many of our best authorities say that 20 times that much land can be sprinkler-irrigated. It will remove forever the biggest gamble that the farmer faces and save him many whole years of almost total crop loss.

Many farmers already have enough available water to put their entire farms under portable irrigation, if necessary. One farmer who specializes in hybrid seed corn at $10 a bushel lost his entire 1953 crop as a result of a drought. Although the 1954 drought was more severe he produced $75,000 worth of corn from 100 acres. He had installed an irrigation outfit tied to an adjoining river.

It is well to emphasize that no farmer anywhere should buy an irrigation system until his farm is engineered for it by a trained technician. This determines the kind of system he needs and how it should be set up. Without this technical assistance he may lose his shirt.

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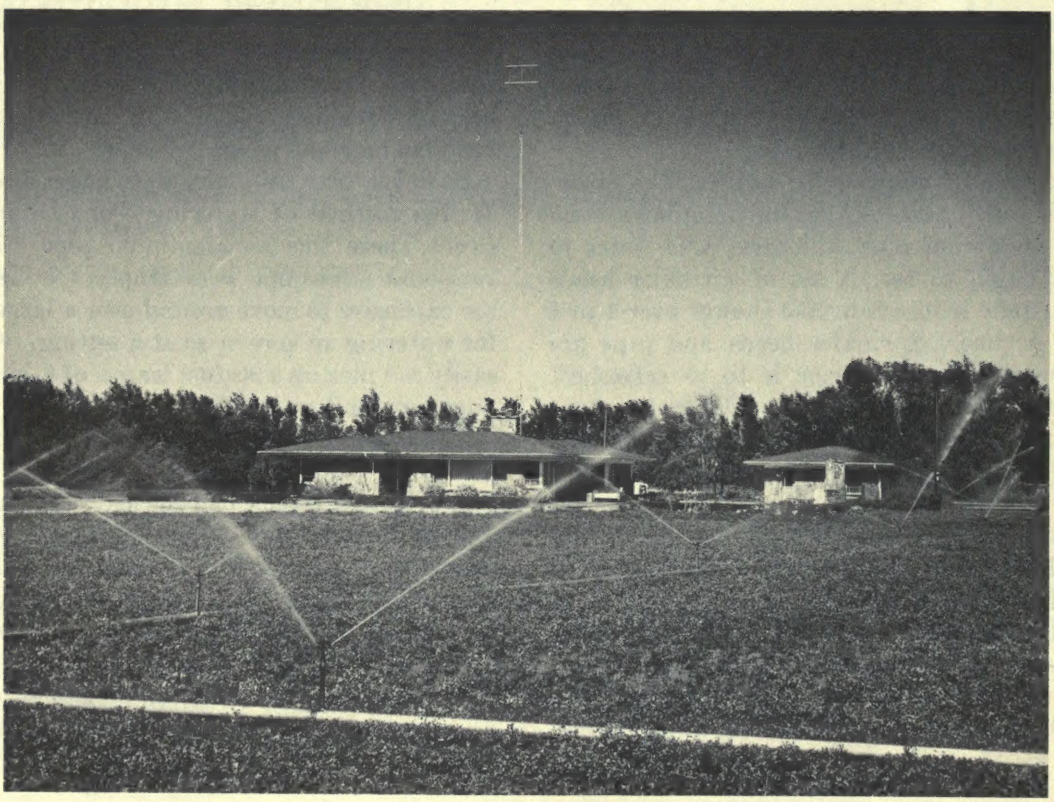
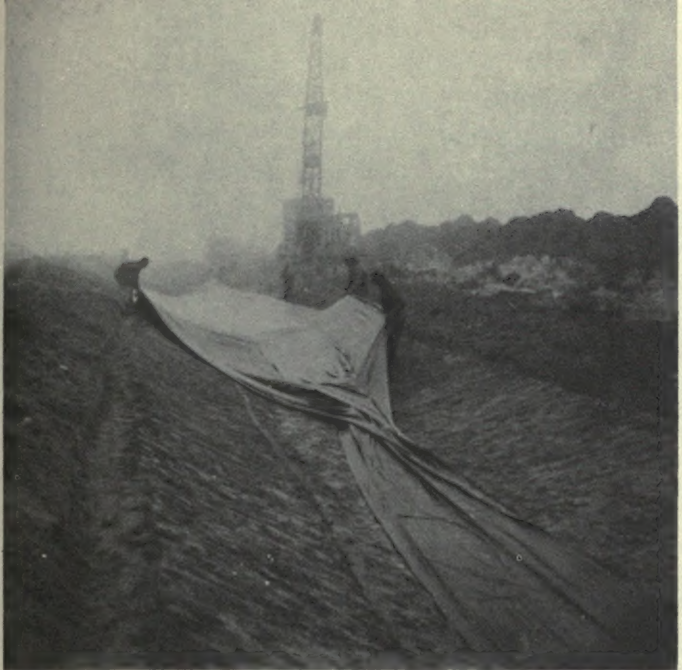
Levi Burton of Bartley, Nebraska, irrigates his alfalfa field by sprinkler near his new home, a result of good irrigated crops. ***Photo by L. C. Axthelm, Region 7.***





PLASTIC CANAL LININGS

As a part of the continuing search for satisfactory and low-cost linings for irrigation canals that can be installed by project forces, using a minimum of equipment normally available on an irrigation project, an experimental test section of buried plastic membrane lining was constructed on a lateral of the Heart Mountain Division, Shoshone Project, Wyo. The work was accomplished in the fall of 1957 and a prefabricated, black, vinyl plastic material 8 mils in thickness was used for the 400-foot long experimental installation.

Preparation of the lateral subgrade and installation of the plastic lining were performed by project forces, using project equipment. The lining material was donated by the Bakelite Co. of New York. The black, 8-mil thick vinyl film was furnished in one piece 17 feet wide and 400 feet long. The weight of the plastic lining material was approximately 350 pounds. The film was packaged at the factory, accordion-folded into a cardboard box about 4-feet long by 1-foot thick. The Bakelite Company is currently wholesaling this material at about 40 cents per square yard, according to R. H. Kennedy, Chief, Operation and Maintenance Branch and W. H. Swenson, Head, Materials Section, who reported the installation work.

The lateral was overexcavated to provide for 9 inches of combined earth and gravel cover over the lining after placement. The slopes were flattened to 2½ : 1, and where sandstone was encountered, the subgrade was excavated slightly below grade and refilled with earth material to provide a cushion to prevent possible puncture of the film. The rough excavation was made with a dragline and fine-grading was accomplished with hand shovels, rakes and a lightweight lawn roller. Trenches were cut into the slope at the elevation of the top of the lining, as shown, to anchor the film and to prevent surface water from seeping under the lining. Cutoff trenches 18 inches in depth were excavated at both inlet and outlet transitions to prevent water from getting under and displacing the lining.

Placing of the lining was easily accomplished by using a two-wheel trailer in the bottom of the lateral to carry the box containing the plastic. The lining was first unfolded again toward each side slope.

Preparation of the subgrade for lining.

Gravel cover is hauled to site and removed from truck with clam shell bucket and placed in the canal section in one operation.

A minimum amount of earth material was placed in the trench at the top of the lining by hand methods to hold the plastic in place while the cover was being placed by the dragline. Placement of the lining for the entire 400-foot reach was completed without difficulty in about 1 hour. The plastic remained soft and pliable even though the temperature was only slightly above freezing during placement.

The earth cover was silty sand material obtained from over-excavating the canal section. A template was constructed and pulled along the bottom and side slopes of the canal to level the earth cover prior to placing the gravel cover. No particular difficulty was experienced in placing the earth cover. The plastic apparently withstood the impact of the material dropping from the dragline bucket without any noticeable tearing of the lining. No doubt the excellent condition of the canal subgrade contributed to the successful application of the cover without damage to the membrane.

The gravel cover was hauled to the site in dump trucks and picked out directly from the truck with a clam shell bucket and placed in the canal section in one operation.

In order to secure comparative costs which could be used for estimating the cost of similar work on other projects, labor and equipment costs were kept on the installation. These are given below. A minimum of supervision normally would be required for installation of this type of lining and the costs would be reduced materially on a larger installation using experienced personnel. Accordingly, costs somewhat lower than shown would normally result.

Dragline, excavation	$216.00
Dragline, placing earth and gravel cover	204.00
Loader, loading gravel trucks	36.00
Patrol, cleanup work	88.00
Labor, fine grading subgrade	168.55
Labor, smoothing earth cover	164.80
Labor, smoothing gravel cover	69.01
Transportation	43.74
Engineering and supervision (field costs)	206.17
Total installation cost	1,196.27
Installation cost per square yard (756 square yards)	1.58

Approximately the same amount of subgrade preparation would be required for any type of membrane lining. The ease and time required to install this plastic membrane was a large factor in reducing the costs.

Where the canal prism is more than 20 feet and the length to be lined more than 400 feet, additional lengths of the plastic could be joined in the field to reduce the weight for handling conveniently. The Bakelite Co. advises, however, that practically any width and length of film can be supplied and handling in the field will be the controlling factor on the size of sheet to be used. The ease in making field splices between two sheets of the vinyl plastic film was illustrated during the installation where it became necessary to patch a tear in the film which occurred during the unfold-

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HAVASU LAKE NATIONAL WILDLIFE REFUGE

Havasu Lake National Wildlife Refuge, established in 1941 to protect and manage the wildlife resources on the reservoir back of Parker Dam, is situated on the reservoir formed by Parker Dam on the Colorado River, 17 miles north of Parker, Ariz. It extends north from the dam nearly 55 miles to the upper end of the swampy backwaters between Needles, Calif. and Topock, Ariz. The dam was constructed by the Bureau of Reclamation in 1938 to provide a desilting basin and forebay for the aqueduct of the Metropolitan Water District of Southern California.

The refuge may be divided into four distinct sections: Havasu Lake, Mohave Canyon, the Topock area, and the Bill Williams Delta. Havasu Lake is the open body of water behind Parker Dam. It is approximately 40 miles long, and varies in width from one-fourth mile to more than 3 miles. The shoreline of the southern half of the lake is characterized by precipitous, rocky cliffs of volcanic origin. The upper half of the lake is margined by desert areas. There are a few stretches that are low and sandy. Waterfowl food plants, such as sego pondweed, grow profusely in many sections. Although it is an artificial reservoir, Havasu Lake's shoreline fluctuates not more than 4 or 5 feet per year. This guarantee of moisture has resulted in a fringe of brush and trees, particularly in the upper part of the lake, where screwbeans, black willow, cottonwoods, and salt cedars form a backdrop to coves and bays.

In Mohave Canyon the lake becomes a river, restricted much of the way by towering red cliffs, with many secluded backwaters margined by bulrush and cattail. The canyon extends for about 10 miles. Scenic features of the canyon include Mohave Rock, which splits the river at the lower end of the canyon; Devil's Elbow, where the river

ABOVE, HARRIS HAWKS

by LOUIS D. HATCH, Refuge Manager, Havasu National Wildlife Refuge

Two marbled godwits and a willet on sandbar at north entrance to Gun's hole in Topock area.

Photograph by Gale Monson, U. S. Fish and Wildlife Service.

makes two 90° bends in less than half a mile; and Picture Rocks, where Indian petroglyphs, or rock-writings, are viewable from the water.

The Topock Area consists of about 28 square miles inundated by the river since the completion of Parker Dam. The channel of the Colorado River is confined to the west edge of the area by a large levee constructed by the Bureau of Reclamation. The bulk of the area is a network of channels and ponds set in low ground. Its east side, where the refuge extends for nearly 10 miles above Topock, is a deep lake. There is much flooded brushland, and the stands of cattail and bulrush are the most extensive in Arizona.

The fourth and southernmost section of the refuge, the Bill Williams Delta, is a small area of less than two square miles, formed by the deposition of silt from the Bill Williams River. This area is located in the midst of towering cliffs of volcanic rock, some of which are 2,000 feet in height. Underground water seeps to the surface to form a few small streams, which often are converted into a series of ponds by beaver dams. The delta area provides a wide range of wildlife habitats, and many of the rarest plants and animals of Arizona are found here. Permission to visit this area must be obtained from the Refuge Manager at Parker, since the area is inaccessible except by vehicles with four-wheel drive.

Slightly less than half of the 45,761-acre area lies in California; the remainder in Arizona. Wintering populations of ducks and geese find their way through the mountainous or eastern section of the Pacific flyway into the Colorado River drainage, making extensive use of the refuge. The development of waterfowl habitat on the refuge is still in progress. Habitat improvement by brush control for the encouragement of Bermuda grass and other browse is expected to prove attractive to geese and other waterfowl.

The fall migration usually begins in August with the arrival of large numbers of pintails and green-winged teal. In October, the wintering Canada and snow geese, mallards, American widgeons, and gadwalls begin arriving. The re-

MOHAVE CANYON above Mohave Rock.

turn flight northward reaches its peak in February and March. Coots are present by the thousands from September through March. Many species of ducks, including the common golden-eye and the hooded merganser, are present during the winter months. During migrations, loons, grebes, glossy ibises, long-billed curlews, willets, marbled godwits, ring-billed gulls, and Forester's and black terns are commonplace. Among the brush and trees of the shoreline the Gambel's quail, great horned owl, roadrunner, white-winged dove, ladderbacked woodpecker, blade phoebe, verdin, crissal thrasher, black-tailed gnat-catcher, yellow warbler, yellow-breasted chat, and blue grosbeak may be observed.

Mohave Canyon, with its sequestered back-waters, is home to a variety of birds. A limited number of ducks and other water birds nest on the Havasu Lake Refuge. Nesting colonies of herons, cormorants, and both common and snowy egrets can be found in April and May. The Harris' hawk, one of America's rarest birds of prey, nests commonly in the Topock Area. Prairie and peregrine falcons, white-throated swifts, and canon and rock wrens should be watched for along the cliffs. The Topock Area is notable for its large winter concentrations of waterfowl. Among the smaller birds, vermillion flycatchers, marsh wrens, yellow warblers, yellow-throats, red-winged blackbirds, and song sparrows breed commonly. Tree swallows gather in incredible numbers during migration, and hundreds spend the winter. Beaver are numerous on the refuge. These valuable fur animals prefer willows, which grow profusely in some sections, but utilize the extensive stands of cattail for food and for the construction of their lodges. Musk-rats are also present in considerable numbers. A few bighorn sheep and wild burros inhabit the rugged, mountainous terrain which extends to the lake margins in a number of places. The bighorns are found only on the Arizona side.

Fish abound in the refuge waters, including large-mouth bass, channel catfish, bluegill, crappie, and carp. A year-long season is permitted, subject to the joint regulations of California and Arizona, except at such times and in such places where closing of an area to fishermen is advisable to give better protection to birds. Bullfrogs inhabit the Topock Area and many parts of the lake, and soft-shelled turtles are common.

Bighorn sheep, 2 ewes, Mohave Canyon, looking north. ***Photograph by Gale Monson, U. S. Fish and Wildlife Service.***

Portions of the refuge area are open to public shooting during the waterfowl season. It has been learned through banding that many of the birds taken by hunting are the ducks and geese which nest in the Mountain States of Utah, Wyoming, Idaho, and Montana.

Firearms are prohibited at all times, except shotguns, during the open waterfowl season in those areas open to hunting. Molesting wildlife or damaging plants is prohibited. Visitors are especially cautioned against disturbing resting or feeding flocks of birds, and are expected to stay away from nesting colonies.

Havasu Lake is popular for swimming, boating, camping, and water skiing. The lake attracts large numbers of visitors throughout the year and, situated as it is in a desert section of the country, provides one of the few recreational areas in the region available to the public.

While public use is secondary in function to a wildlife refuge, public use on Havasu Lake has increased 600 percent in the past 10 years. Lake

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Havasu provided 250,000 visitor's-days-use last year, and it is anticipated that by 1975 it will receive more than one million visitor's-days-use. As

Young brown Pelican.

an example of the increased use, two 12-hour counts taken during the Memorial Day holiday reflected these interesting results:

	Cars	*Boats*	*People*
1957	335	210	1,532
1958	864	705	3,360

Some 3,000 visitors took the self-guided tour at the Parker Dam Powerplant last Memorial Day weekend.

To accommodate fishermen, water sports enthusiasts, picnickers, campers, sightseers, and naturalists, 8 concessions have been established, 5 on the lake and 3 near Topock. A wide range of facilities is available at these concessions, among them rental boats and outboard motors, motels, housetrailer parks, cabins, and camping space. Due to the extent of the area, it is best for visitors to make local inquiry at such places as Kingman, Parker, and Topock in Arizona, and Needles and Vidal Junction (on U. S. Highway 95) in California. One or more concessions are accessible from any one of these points. The concessions are, respectively, Shorty's Camp, Gunn's Camp (Catfisherman's Paradise), and Five-Mile Landing at Topock, accessible from U. S. Highway 66; Site Six, on the Arizona side of the lake, reached by turning south off Highway 66 about 10 miles east of Topock (this concession has an excellent 6,000-foot landing field); Havasu Landing, on the California side of the lake, to which an all-paved road extends from U. S. Highway 95 about 21 miles south of Needles; Roads End Camp and Black Meadow Landing, on the California side of the lake, accessible by road from Parker Dam; and Havasu Springs, on the Bill Williams arm of the lake, reached by driving across Parker Dam from the California side.

Camping is permitted for not more than 72 hours (3 days) at any place along the shore of Havasu Lake except Mohave Canyon, provided that the camper maintains a neat camp and removes all traces of same upon leaving. Camping facilities are provided at most concession sites for a nominal fee. Camping is not permitted along the Bill Williams arm of the lake, and only in designated areas in the Topock Area.

A 10-year recreational development program has been prepared to cope with the advancing tide of the recreational seeking populace of Southern California. Campground development has been initiated along both the Arizona and California shores of Havasu Lake. These sites will contain picnic tables, fireplaces, and toilet facilities. Wood for campfires must be provided by campers and picnickers. Use of campstoves is desirable.

Water skiing has increased at a fantastic rate, making it necessary to establish definite ski areas on the lake. The ski zones provide the most compatibility among the interests of a wildlife refuge, water storage, and the varied recreational uses of skiing, fishing, hunting, swimming, and sightseeing. # # #

CANAL LININGS

Two publications that may be of interest to you on the subject of canal-linings are: (1) Lining Irrigation Canals, and (2) USBR's Lower-cost Canal Lining Program.

The Portland Cement Association's illustrated, 32 page booklet "Lining Irrigation Canals," discusses the need for canal linings, the economics of lining, general design considerations and describes the types of linings that can be constructed with portland cement. Included are concrete, plastic soil-cement, compacted soil-cement, and shot-crete linings; precast lining units and pipe; and cast-in-place concrete pipe. Copies of the Portland Cement Association booklet can be obtained by writing the Association at 33 West Grand Avenue, Chicago 10, Ill.

Steel storage building 60′ x 32′ with sections painted white to test the effect of the paint. *Photograph by T. E. Bond, U. S. D. A., Univ. of Calif.*

WHITE PAINT FOR FARM BUILDINGS

Characteristics of White Paint Prevent Excessive Heating of Metal Farm Structures by Radiation from Sun, Sky, Environs

PART OF A GALVANIZED STEEL storage building in the Imperial Valley was painted—to study the influence of white paint on the thermal environment within a steel building and under metal animal shades—as part of a research project concerning the modification of the environment to improve animal gains.

The long dimension of the storage building was oriented north and south. The exterior of the south end—and the south 20′ section—were painted with standard white house paint. The center 20′ section was painted with bone-white paint. The north section and north wall were left unpainted.

Temperatures of the different sections were measured with thermocouples attached to the inside surfaces. The temperatures of the painted surfaces were greatly reduced. At 1 p. m., when outdoor air temperature was 100° F., and the temperature inside the building was 102.5° F. surface temperature reductions were: 25.0° F., west wall; 42.6° F., west roof; and 41.0° F., east roof. There was little difference in the temperatures of the unpainted north end and the painted south end even though the south end was in the sun all day. In effect, the white paint put the south end in the shade. There was little difference in the effect of the two types of white paint.

With only one building available for study, it was not possible to compare directly the air temperatures in painted and unpainted buildings. However, it was possible to calculate from the test data what the air temperatures within two such unventilated buildings would be, based upon actual surface temperatures of the painted and unpainted sections. These calculations were made for three different sets of data. The air temperature in the white painted building was taken as the air temperature inside the test building, and the temperature inside the unpainted building was calculated on the basis that the amount of heat transferred to the air in both buildings was the same. Such considerations indicated air temperature differences as great as 28° F. within the two buildings.

Calculated temperature differences within unpainted and white painted galvanized steel buildings based on actual surface temperature measurements of painted and unpainted sections.

Date 1955	Time p. m.	Inside air temperatures, ° F.		
		White	Unpainted (calculated)	Temperature difference
June 25	1:00	102.5	130.5	28.0
June 25	2:00	100.0	116.8	16.8
June 26	2:00	102.5	119.8	17.3

Radiation from the surfaces was measured with a directional radiometer. At 2 : 30 p. m. the white surfaces in shade—east side—gave off 184 B. t. u.—British thermal units—per hour per square foot compared to 172 B. t. u. per hour per square foot from the unpainted surfaces, indicating a more rapid emission of energy from the white surfaces. In the sun—west side—315 B. t. u. per hour per square foot came from the white surfaces and 231

by T. E. BOND, C. F. KELLY, and N. R. ITTNER

from the unpainted surfaces. The greater amount of energy from the white surfaces indicated they had both greater reflectivity and greater emissivity than the unpainted surfaces—very desirable characteristics in building heat load consideration.

PAINTED ANIMAL SHADES

Shades are important for protecting livestock from radiation from the sun and sky and, indirectly, from the surroundings. Because the shade material is generally hotter than the surface of a shaded animal, the animal receives radiation from it.

The radiation characteristics of both surfaces of the shade material influence the radiation heat load on the animal. The characteristics of the top surface have a major influence on the temperature of the shade material; the emissivity of the bottom surface greatly affects the quantity of energy that will be emitted to the animal. In addition, the reflectivity of the bottom surface determines the quantity of incident energy from the ground that will be reflected back down to the animal.

White paint was tested as a means of reducing the temperature of metal shades to reduce the heat load on animals under them.

Three flat, portable shade frames 8′ x 8′ x 4′ high were covered with corrugated embossed aluminum roofing. One shade was left unpainted. White paint was applied to the top surface of the remaining two and the bottom of one of these was painted with black paint. White paint and the unpainted aluminum sheet reflect about the same amount of solar energy but the emission of white paint, at ordinary shade material temperatures, is much greater. Because of this the temperature of the white painted aluminum was as much as 15° F. lower than the unpainted aluminum. The radiant heat load—as indicated by black globe thermometers—was as much as 13 B. t. u. per hour per square foot less under the white surfaced aluminum.

The third shade with the white top and black underside remained at about the same temperature as the shade with only the white top surface. However, because the black underside did not reflect energy from the ground back down to the animal, the radiant heat load under the white and

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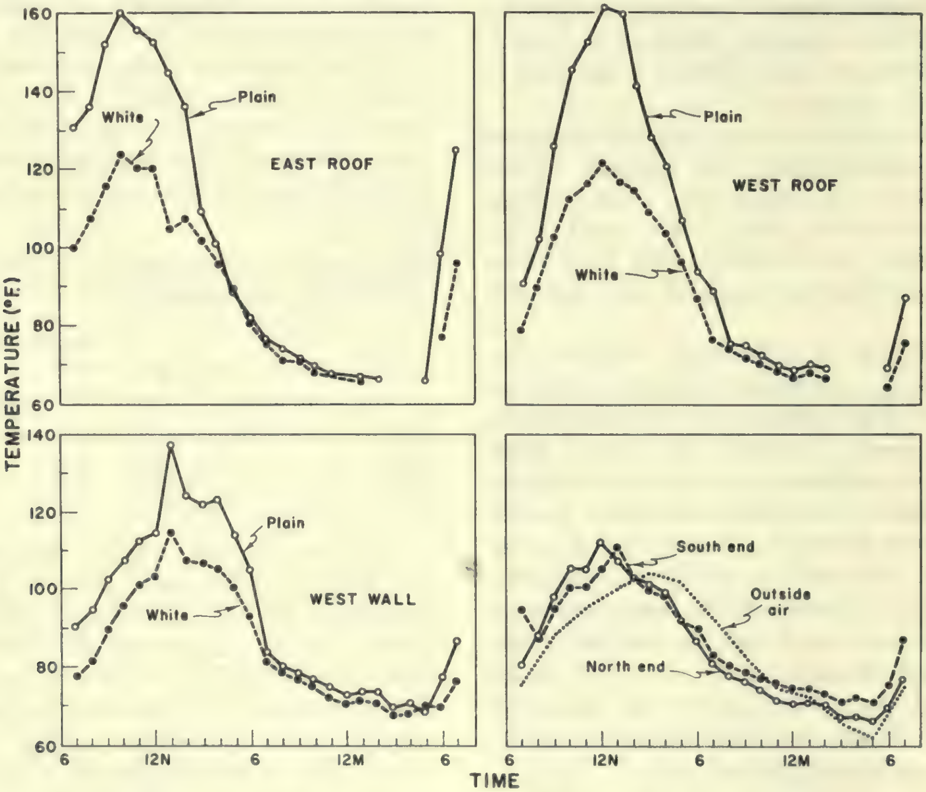


Above—24-hour comparison of surface temperatures of painted and unpainted sections of steel storage building.

NEW AGRICULTURAL DEVELOPMENT

The following are excerpts from recent releases of the Climax Molybdenum Co., and are published for the consideration of and evaluation by the Irrigation Farmer. Additional information should be obtained from County Extension Agent or State Agriculture College. Ed.

An agricultural advance designed to help farmers increase the productivity of their land was unveiled in Portland, Oregon, by Climax Molybdenum Co., a division of American Metal Climax, Inc., before a special meeting of County Agents and agronomists from Oregon and Washington. It is a new, easy-to-apply form of Molybdenum, an element which is essential to the growth and health of crops, especially legumes.

The new formulation, a seed treatment compound known as Moly-Gro, can effect harvest increases as high as 50 percent on peas, alfalfa, peanuts, soybeans, clover, and many other crops. According to William M. Stilwell, manager of agricultural sales and development for Climax, this development opens the door for the first time to practical commercial application of molybdenum to crops and ultimately to greater income per acre for farmers.

Molybdenum is a micronutrient required by plants in only minute quantities—but it serves vital functions in the fixation and utilization of nitrogen. It enables the root nodule bacteria of legumes to fix nitrogen from the atmosphere. Further, in building protein nitrogen, plants first must convert nitrogen into a simpler form. Molybdenum plays an important role in the plant enzyme system, making this conversion possible.

Molybdenum has been put to work on Australian and New Zealand soils with excellent results. Soils which once yielded just a sparse scattering of native legumes were able to produce luxuriant

Above, Dr. H. M. Reisenauer, Washington State College, exhibits the increase possible. Peas were picked from test plots of same size. Molybdenum treated peas on right.

Preparation of seed. Moly-Gro is mixed with water and passed over the seed before planting.

Treated seed is spread out on canvas to dry before being planted.

carpets of clover. Since the early Australian successes with molybdenum, a number of research programs have been conducted in the United States. These studies have indicated that although not as dramatic as the responses in Australia, many crops and soils in this country show a significant yield increase with molybdenum—as high as 50 percent in some cases.

The Pacific Northwest has already witnessed considerable success in commercial use of molybdenum, particularly on pear crops. New Jersey truck farmers, too, have found that a common disease known as whiptail can be readily controlled in cauliflower when treated with the element, and citrus growers have adopted it to control a troublesome leaf disease called yellow spot.

Both sides of this field were treated and contain thriving green stands. Center area untreated, crop is pale yellow.

Moly-Gro is used to treat seed before planting, rather than added to the soil as a top dressing. Readily soluble, it can be applied to seed while inoculating or slurry-treating with other compounds, for unlike the simple forms of molybdenum, such as sodium molybdate or molybdic oxide, it is completely compatible with inoculants—won't harm the essential bacteria. # # #

White Paint for Farm Buildings

Continued from page 10

black was lower than under the white shade and as much as 18 B. t. u. per hour per square foot lower than under the unpainted shade.

The same advantages were found in painting galvanized steel shades—the surface temperature was reduced as much as 50° F. by painting the upper surface white. In the tests, white painted galvanized steel shades showed an advantage over the unpainted aluminum shades.

These investigations are being continued with other building materials in order to evaluate their usefulness in protecting livestock and farm products from heat.

(T. E. Bond is Agricultural Engineer, U. S. D. A., University of California, Davis.)

(C. F. Kelly is Professor of Agricultural Engineering, University of California, Davis.)

(N. R. Ittner is Specialist in Animal Husbandry, University of California, Imperial Valley Field Station, El Centro.)

Reprinted from California Agriculture through the courtesy of The University of California, Division of Agricultural Sciences.

How to Choose the Right Fertilizer

Farmers generally accept the fact that the proper use of fertilizers is the key to profitable crop production. Yet, a nationwide survey made for the National Plant Food Institute showed that only 40 percent of the farmers were able to choose the proper kinds of fertilizers to correct plant food deficiencies on their crops. With farmers caught between the cost-price squeeze that's frequently aggravated by acreage restrictions, they must turn more and more toward increasing their per acre yield if they are to stay in business.

Fertilizer, alone, doesn't give the answer because the best fertilizer in the world won't be effective unless the soil is in good physical condition, is free of harmful salts, and insects, weeds, and diseases are controlled. If other growing conditions are favorable, then fertilizers can provide the extra yield that can spell the difference between profit and loss.

Fertilizers To Use

How can a farmer find out what fertilizers to use? There are several ways to do so, from talking with his neighbors to getting chemical tests made of his soils and crops. Checking with your neighbor to see what he does to get big yields can be helpful if you follow the same cropping system he does and if your soils are the same. On the other hand, it isn't a good idea to follow another farmer's practices blindly because you seldom find two farmers who do everything exactly the same.

Other sources of information are county extension agents, local Soil Conservation Service Technicians, fertilizer dealers, and the state Agricultural College. These are the people who know what has been found out about fertilizer use in their areas.

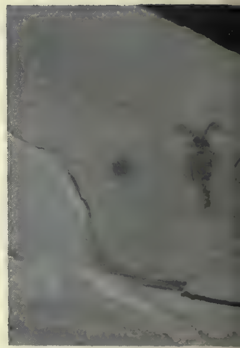
Determining the need for a particular fertilizer calls for some knowledge of the plant food content of soils and crops. There are five common ways to do that, each of which helps to pin down the particular plant nutrient that is needed. They are: (1) Crop requirement for plant food, (2) Soil type, (3) Deficiency symptoms, (4) Soil tests and (5) plant tests.

Crops differ widely in the amount of plant food they must have to give maximum yields. The accompanying table shows the plant food removed in harvesting several crops that are grown under irrigation. Knowing how much plant food a particular crop takes out of the soil, however, doesn't give all the information a farmer must have when he applies fertilizer. Soils differ in their ability to supply plant food. A soil developed from granite, for example, frequently contains more available phosphorus than one developed from limestone or sandstone. Similarly, sandy soils have less storage capacity for nutrients than do clay soils, which is why clay soils are usually "stronger" than sandy soils. Soil surveys have been made in most irrigated areas by federal and state agencies and they offer a guide to the nutrient level as well as to other limitations that are likely to be found.

Continued on page 21

by H. E. DREGNE *New Mexico College of Agriculture and Mechanic Arts, State College, New Mexico.*

Norris Bradbury, left, Director of Los Alamos Scientific Laboratory and Lloyd Pierson, Supervisoy Range and Archeologist at Arches National Monument, Moab, Utah, are shown inspecting a Pueblo-type dwelling.



Many pictographs will
ground. *All photog*

Exploring

Members of an archeological expedition under the direction of the University of Utah are shown approaching a cave once inhabited by Pueblo Indians.

These petroglyphs are some of the evidences of the prehistoric Indians who once inhabited the Glen Canyon area.

for their historical back-
nd B. Slote, Region 4.

Typical of many of the Puebloan houses found in the Glen Canyon stretch of the Colorado River are these partial walls made of sandstone cemented with clay.

en Canyon

Shown are paintings that would probably have reached a height of fifteen feet before their partial destruction.

An entrance to one of the many side canyons off the Colorado River in the Glen Canyon stretch.

MAN-MADE RAIN

Continued from page 2

Even in normal rainfall years there are nearly always enough short dry spells in which crop production can be boosted by artificial rain at the right time. Authorities tell us that in Mississippi, a State which averages 50 inches of natural rain a year, drought has had a retarding effect on crop production in 39 out of 41 years.

Department of Interior officials say we have a lot more water resources than we realize. We get a superabundance of sky water in frequent heavy rain and flood seasons, but it runs off to sea. We are learning ways to store this moisture and ration it out through the growing season as needed. Small creeks are being dammed and lakes created so that a farmer can accumulate the water both during flood and normal flow season. Irrigation authorities say that, on the average, a farm needs a replenishing flow of 7½ gallons per minute per acre to maintain a supply at the same level.

D. S. Mitchell, Assistant Chief of the Division of Irrigation, Bureau of Reclamation, says that every section of the country can now use irrigation some time during almost every year. John Bird, former Associate Editor of Better Farming Magazine, says that over 50 million acres could be watered from existing or easily developed sources, as compared with 3 million acres already being artificially watered in humid areas.

Engineers say that water from the Mississippi, Ohio, Missouri and other large rivers could be pumped into large reservoirs spotted at strategic spots, even long distances away. Think how much water these huge streams carry off to the sea during flood seasons.

Many scientists are dreaming of a cheap process of desalting ocean water and piping its superabundance to vast areas of our country. They have already reduced the cost of desalting to an unbelievably low mark. They believe it is only a question of time when they can make it virtually as cheap as fresh water for irrigation.

In the meantime, seven times as much of our fresh water supply is going to waste as is being used. Our most immediate need is to salvage this great asset.

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# # #

Completed lining installation.

Plastic Canal Linings

Continued from page 3

ing process. The repair was made without difficulty and without delay to the work using solvents and materials furnished by the manufacturer. The manufacturer reports that field splices made in this manner can be expected to develop at least 80 percent of the tensile strength of the material.

The ease in making field splices between two sheets of the vinyl plastic film when it became necessary to patch a tear is illustrated below.

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the ERA that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

AQUATIC AND BANK WEEDS
cause concern, research, and action

Aquatic weeds which grow submerged in, floating on, or emergent from water are causing tremendous losses in irrigation and drainage canals, in ponds, lakes, and marsh lands. A closely related part of the problem is that of bank weeds which grow at the waterline or on the banks above or on wet lands in marshes. The demands of our increasing population for more water for irrigation, for potable and industrial uses, recreation, game and fish have made the problem more acute and have made us aware of its growing importance. The increasing awareness of the aquatic and bank weed problem along with the recent spectacular advances in herbicides available for evaluation have caused renewed hope that these weeds can be economically controlled and have stimulated increased research and action programs in that direction. Research has already developed a number of improved methods now in use in action programs on control of aquatic and bank weeds, and there is reason to believe that many more problems can be solved through research.

ABOVE. Willows on Strawberry Highline Canal sprayed with Weedone.

Aquatic and bank weeds cause losses of at least eight types: (1) Aquatic weeds reduce the flow of water as much as 97 percent in more extreme cases. Reduce flow causes high water levels in canals and streams resulting in (*a*) flooding, (*b*) seepage into adjoining areas or poor drainage, (*c*) breaks in canal banks, (*d*) greater water losses from evaporation, and (*e*) inadequate delivery of irrigation water to farms or inadequate drainage of water from farms. In addition, reduced velocity of flow causes increased sedimentation which reduces carrying capacity and makes more frequent mechanical cleaning necessary. (2) Floating weeds and other aquatic weeds that break loose obstruct weirs, gates, and other structures and often create flood hazards during storms. Also, algae and fragments of other submersed aquatic weeds clog sprinklers in sprinkle irrigation systems. (3) Aquatic and bank weeds provide breeding grounds for obnoxious insects such as mosquitoes. (4) They prevent economic uses of farm ponds and reduce recreational values of lakes and ponds by interfering with fishing, swimming, boating, and hunting. (5) Aquatic weeds interfere with navigation of otherwise navigable streams. (6) Decaying organic matter produced by aquatic weeds cause objectionable odors and flavors in potable water. (7) Emergent aquatic weeds and bank weeds transpire tremendous quantities of water into the air causing serious losses in areas of water shortage. (8) Bank weeds prevent the proper inspection and maintenance of irrigation and drainage canals and shorelines of reservoirs.

No overall cost figures are available on the total value of losses caused by aquatic and bank weeds or on the total costs of controlling these weeds in the United States. However, a few examples of such costs and of the extent of the problem may be sufficient to give an indication of the economic importance of waterweeds and bank weeds. Annual losses from aquatic and bank weeds on the 130,000 miles of irrigation canals and laterals in

by F. L. TIMMONS AND D. L. KLINGMAN

17 Western States totalled $25,500,000 according to a survey conducted in 1947 and 1948 by the Bureau of Reclamation. This figure probably would be considerably higher now because of increased prices for farm products and the addition of at least one million acres of new land under irrigation in the last 10 years.

Figures supplied by the United States Army Corps of Engineers show that since 1939 over $500,000 has been spent on the Potomac and Mohawk-Hudson Rivers in attempts to control water chestnut, and over $5 million has been spent in controlling water hyacinth in Florida, Alabama, and Louisiana since 1905. These figures represent only small areas, and in spite of these expenditures we still have both water chestnut and water hyacinth with us. In Arkansas, Drainage District No. 16 is spending $5,000 to $8,000 annually for mechanical control of water stargrass in about 20 miles of drainage channel. This is $250 to $400 per mile for underwater cutting, which is the method used.

The Central and Southern Florida Flood Control District, supported by Federal, State, and county funds, has a network of 500 miles of major drainage canals in which the annual operating costs for aquatic weed control exceed $50,000. In addition, about $30,000 is spent on aquatic weed control in the smaller drainage and irrigation ditches serving 15,570 square miles of agricultural land in southeastern Florida.

The Los Angeles Department of Water and Power reported the use of 135 tons of copper sulfate during the 1955 season for control of aquatic weeds in potable water supplies at a total cost of $30,000. Using their figure of $30,000 and multiplying it by the large number of cities in the United States which have aquatic weed problems in their potable water supplies would give a sizeable figure.

In 1951 there were an estimated 1,666,000 farm ponds in the United States, and the annual rate of increase was 38,000. Of these, 627,000 have been built with Soil Conservation Service technical assistance. According to Philip F. Allan, Biologist, Soil Conservation Service, Ithaca, N. Y., "Nature abhors a farm pond and sets about destroying it. Through an orderly succession of various kinds of plants—beginning with bacteria and extending through the algae, the rooted submerged aquatics, the floating plants, marsh plants, bog shrubs and swamp trees—Nature sets about converting ponds to dry land. It is man's very difficult job to prevent this occurrence or at least to slow it down."

Dead morning glory (bindweed) overhanging irrigating system.

The traditional methods of controlling aquatic and bank weeds include handcutting or pulling, and mechanical mowing, chaining, dragging, or crushing. These methods are still in use in many areas and in many situations but, with the present high labor costs of extensive weed infestations, they are too slow and expensive for extensive use. In most instances the hand and mechanical methods give only partial or temporary control. With these methods the best that irrigation or drainage districts, farmers, and others can do is fight a defensive battle against aquatic and bank weeds.

Research on control of aquatic and bank weeds has lagged considerably behind research on control of weeds on crop lands and range lands and is still only a small fraction of the research being conducted on land weeds. However, some research on aquatic and bank weeds has been under way for about 10 years and has resulted in the development of several improved control methods. Research on control of aquatic and bank weeds was begun in 1947 and 1948 by the Agricultural Research Service and the Bureau of Reclamation working cooperatively. Some research had been done before that time by a few state experiment stations.

The first improved method developed by the cooperative research was the discovery and development of aromatic solvents for the control of submersed aquatic weeds in irrigation channels. The use of these aromatic solvents or methylated hydrocarbons, consisting largely of xylene, has been increasing rapidly in the West since 1952 and totaled approximately 580,000 gallons in 1957. Based upon comparative cost figures compiled by Man-

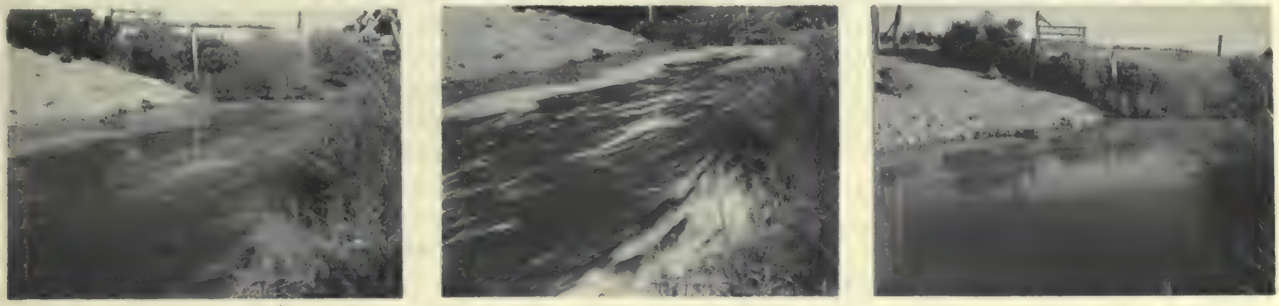
ager Carroll F. Wilcomb of the North Side Canal Co., Jerome, Idaho, the use of this improved chemical method throughout the Western States in 1957 resulted in a saving of $1,084,600 as compared to the cost of controlling submersed aquatic weeds by the previously used mechanical methods. Also, the weed control provided by aromatic solvents was much superior to that by mechanical methods and resulted in reduced crop losses from inadequate irrigation, water losses, and other causes. Directions for using aromatic solvents for controlling submersed aquatic weeds in irrigation systems are given in USDA Circular 971.

Aromatic solvents in mixture with gasoline and heavy chlorinated benzenes are also being used successfully for control of submersed aquatic weeds in water control canals in Florida. The recommendations for this use are given in Florida Agricultural Experiment Station Circular S–97.

Another improved method developed by the cooperative research between the Agricultural Research Service and the Bureau of Reclamation is the control of cattail by spraying with 4 to 6 pounds per acre of a low volatile ester of 2,4-D and a 1 to 20 oil-water emulsion (1 gallon of diesel oil to 20 gallons of water) using a total volume of 150 to 300 gallons of emulsion per acre of cattail. The first spraying should be done just before cattail heads appear and retreatments made as necessary, usually about three applications over a 2-year period for complete elimination. Cost figures reported by Bureau of Reclamation irrigation projects show that the costs of eliminating cattail by this method range from $24.12 to $43.42 per mile of canal as compared to costs of $407 to $418 per mile for draglining, the most common mechanical method of controlling cattail.

More recently, research has shown that dalapon (2,2-Dichloropropionic acid) and amitrol (3-amino-1,2,4-triazole), alone or in combination, are effective in controlling cattail. While these herbicides are more expensive than 2,4-D ester in oil-water emulsion, this disadvantage is offset, at least in part, by three distinct advantages: (1) dalapon and amitrol are effective in low volumes of 12 to as low as 5 gallons of water per acre and therefore may be applied by airplane, whereas 2,4-D is effective only when applied in high volumes of 150 gallons per acre or more by ground equipment. (2) Dalapon and amitrol involve less hazard of spray drift and volatile fumes onto sensitive crops, and (3) one spray application per growing season usually will give as good control of cattail as two repeated applications of 2,4-D in oil-water emulsion.

One of the best examples of the benefits from improved methods to a total program of controlling aquatic and ditchbank weeds is provided by the Imperial Irrigation District of Southern California. This District has 3,100 miles of canals and drain channels which irrigate and drain approximately 400,000 acres of land. During the 5-year period, 1945–49, inclusive, when burning with oil burners was the only available method of control, the Imperial District spent $1,318,000 on weed control. The operation was confined to the inside channels, but it was still necessary to burn an average total of 22,000 acre-miles of ditchbanks each year, because of the frequency of burning required, and to chain or hand clean submersed aquatic weeds in many hundreds of miles of channel. During the next 5-year period, the Imperial Irrigation District gradually adopted improved chemical methods which consisted of spraying with 2,4-D, with contact oils, TCA (sodium trichloroacetate), and dalapon for control of bank weeds and treating with aromatic solvents for control of submersed water weeds. During 1955–57, the District was able to extend its improved chemical methods to begin the successful



Left, Sego Pond Weed infestation in the Irish-American Canal, Humboldt project. Center, water treated with blanket of Beneclor. Right, Sego Pond Weed has disappeared to some extent and remaining weed is lifeless.

eradication of several serious weed problems that had resisted all control efforts before. The District sprayed an average of 4,920 acre-miles of cattail and woody growth with 2,4-D-TCA mixture and sprayed 3,729 miles of phragmites with dalapon. In 1957 only 602 acre-miles of ditchbank were burned as compared with 6,500 acre-miles in 1955 and 22,000 acre-miles per year during 1945–49. Mr. Oscar L. Fudge, superintendent of the Imperial Irrigation District, stated that the improved chemical methods made it possible for the District to change from a defensive program to an offensive control program and to make important gains in eliminating aquatic and ditchbank weeds at very little increase in cost despite rising prices.

Copper sulfate has long been used as an algicide for the control of algae. Recent research and experience by the Bureau of Reclamation and the Los Angeles Water and Power Department show that a continuous feed application or frequently repeated applications of copper sulfate for control of algae also controlled or inhibited the growth of rooted submersed species. The chief disadvantage of copper sulfate is that it is toxic to most species of fish at concentrations above 1 p. p. m. The maximum tolerance limit of fish and the minimum concentration necessary for control of algae are too close together for extensive use of copper sulfate in ponds and lakes where saving the fish has top priority.

Treatment with sodium arsenite solution at 4–10 p. p. m. concentration of arsenious oxide (As_2O_3) has been widely used for many years to control submersed weeds in lakes and ponds. Most species of fish will tolerate up to 11 or 12 p. p. m. of arsenious oxide without injury, which permits the removal of aquatic weeds from ponds and lakes without serious loss of fish. The chief disadvantage of sodium arsenite is its toxicity to humans and warm blooded animals and the consequent necessity for extreme care in applying and handling this chemical. Publications giving directions for the use of sodium arsenite in the control of aquatic weeds are available and should be closely followed.

In recent years the research departments of several manufacturers of herbicides have diverted part of their attention from herbicides for land weeds to the development and screening of chemical compounds for aquatic weed control. Because of this shift in interest, more than 20 new

Treating aquatic weeds by admitting a commercial weed killer within a Parshall flume.

herbicides now show definite promise for control of aquatic weeds, and many more compounds are being evaluated by commercial and public research agencies.

The development of promising new aquatic herbicides and the increased public awareness of the serious aquatic weed problem in lakes and ponds has resulted in expanded action and research programs on control of these weeds by State departments of conservation and fish and game. Some of the States that have been most active in this field are New Jersey, Wisconsin, New York, Oregon, Massachusetts, and California. State experiment stations in Alabama, Michigan, Oregon, California, and other States have active research programs under way. The United States Fish and Wildlife Service and the Soil Conservation Service also have extensive action programs and are conducting research on the control of aquatic and bank weeds.

In 1957, Congress made funds available for a considerable expansion in research on control of aquatic and ditchbank weeds by the United States Department of Agriculture, Agricultural Research Service. Existing research programs in Montana, Washington, and Wyoming were enlarged. New research projects were begun in Arkansas and Florida in cooperation with the State experiment stations, the Central and Southern Florida Flood Control District, and other agencies. The cooperative research program between the Agricultural Research Service and the Bureau of Reclamation at Denver, Colo., was reactivated and enlarged to comprise four research

Continued on page 27

V. H. Gledhill, New Mexico A & M College, is using a photoelectric colorimeter to determine phosphorus in soils.

How to Choose the Right Fertilizer

Continued from page 13

Deficiency Symptoms

Deficiency symptoms, such as yellowing of leaves (nitrogen deficiency) and purpling in corn blades (phosphorus deficiency), show that a crop is suffering from a lack of adequate nutrients. Unfortunately, fertilizing on the basis of deficiency symptoms is like locking the barn door after the horse is stolen: by the time the deficiency symptoms show up, yields are already hurt. In most cases, fertilizing then won't bring the yields back up to where they would have been if the crop had been adequately fertilized all along. The symptoms do prove, though, that the kind or amount of fertilizer used wasn't right for that crop and soil, and a change will have to be made.

Soil tests are the best method we have to determine, before a crop is planted, what nutrients are likely to be deficient. They also tell whether the soil contains excess salt, which is a major problem in irrigated areas. If there is too much salt, fertilizers won't be effective no matter how much is applied. Helpful though they may be, soil tests are not perfect for predicting probable response to fertilizer because climatic conditions, for one thing, vary from year to year and have a direct effect on crop yields. They can be, however, a good tool in deciding what fertilizer to use and how much to apply, if the soil samples are taken carefully.

Plant tests tell what a plant is actually getting from the soil, in contrast to soil tests, which tell what the soil is capable of supplying. The plant, itself, is the best indicator of whether the present fertilizer program is adequate or inadequate. There is sometimes a big difference between the amount of plant food in the soil and the amount a crop takes out. This is especially true with nitrogen, whose availability depends heavily on climatic conditions during the growing season. Plant testing, if properly done, has the big advantage of letting the farmer know of a nutrient deficiency or excess before symptoms show up, while there's still time to do something about it.

Testing Plants

Taking a plant sample for testing is much more difficult than taking a soil sample. One reason is

Effect of nitrogen and phosphorus on growth of cotton.

Effect of nitrogen on size of heads of sorghum.

that it's important to know what part of the plant is the best indicator of its nutrient status. With sugar beets, the petiole is preferred for nutrient tests; for alfalfa, the entire top growth is taken; in cotton, the first mature leaf is the best part of the plant to sample. Another reason is that time of sampling is important if maximum benefit is to be gotten from the plant test. Nutrient deficiencies are most likely to occur when the crop is growing rapidly and needs large amounts of plant food. Soils may be able to supply enough nutrients when the crop is growing slowly but may be unable to keep us with a fast growing crop. Plant tests can show whether a deficiency is likely to appear.

After talking things over with his neighbors and agricultural advisors, and after having soil and plant tests made, the farmer decides what fertilizer to buy. Then he wants to know how much good it does, if any. That brings us to the final step: applying the fertilizer to all but a small strip through the middle of the field. Comparing yields on the fertilized part of the field with the unfertilized part will prove whether the fertilizer was effective. Don't think that the fertilizer wasn't any good just because you can't see any obvious difference between the two parts of the field. Most people can't pick out yield differences in cotton, for example, unless one crop is at least 25 percent better than another. And a 25 percent yield increase can make fertilizing a highly profitable practice.

*Plant food composition of crops**

Crop	Yield	Plant food, pounds per acre—		
		Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
Alfalfa	3 tons	140	35	135
Corn	60 bushels	95	35	70
Cotton	1 bale (lint)	65	25	50
Potatoes (Irish)	180 sacks	125	35	170
Sugar beets	15 tons	115	45	145
Wheat	30 bushels	50	20	30

*Table shows pounds of plant food in entire plant when acre yield is as listed in column 2.

Effect of nitrogen and phosphorus on growth of tomatoes.

Painting "Cyclone" Type Fencing

The Consumers Power Co., Saginaw, Mich., has developed a new technique in the maintenance of "cyclone" type fencing used to protect many structures, including substations, pumping plants, material yards and other facilities.

Periodic painting and maintenance of this type of fencing material is often neglected because ordinary methods using hand brushes or spray equipment are time consuming and costly. The power company uses ordinary sweeper's brooms as applicators and report the method to be fast and thorough and economical.

The Columbia Basin Project

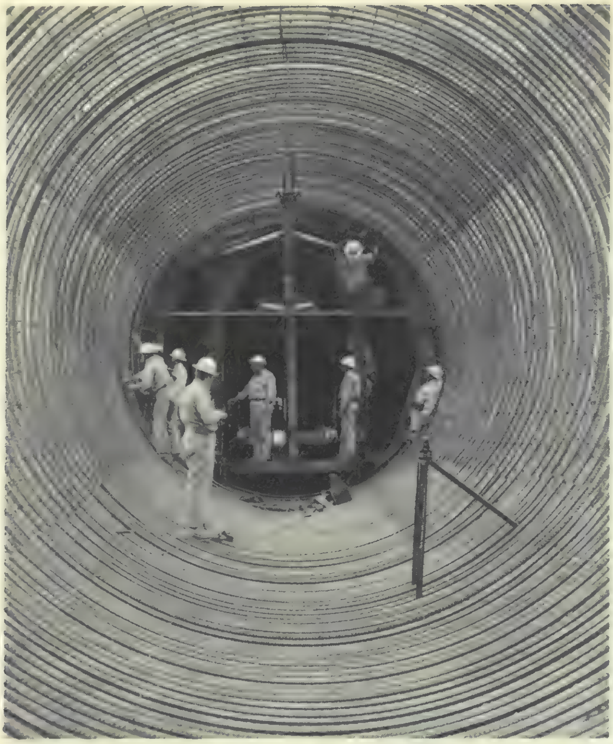
Grand Coulee Dam viewed from the north bank of the Columbia River.

The Columbia Basin Project in Eastern Washington, began in 1933 when work got under way on Grand Coulee Dam on the Columbia River. By 1942 the dam was completed and still stands as the largest man-made concrete structure in the western hemisphere. From its 18 gigantic generators power now flows to farm and city homes, to businesses, and to industrial plants within a radius of 700 miles. Development of this natural resource has broadened the economy of the whole Pacific Northwest.

After World War II, work started on the canals and laterals that will eventually carry water to a million acres of arable land in Central Washington. In 1948, irrigation water was made available to 5,400 acres in the south end of the project near Pasco, Wash. However, it was not until 1952 that the project's irrigation program got into full swing. In 1952, and in each succeeding year, water has been made available to areas varying from 34,000 to 66,000 acres in size. All the lands involved were previously used for grazing or dry-land farming. By 1958 water was available for over 380,000 acres.

The first boost in the economy of the area came from construction activity. This stimulus is being replaced by one based on expansion of the irrigated farming area. A part of the project's contribution to local, regional, and national economies is in the form of returns from processing and sale of commodities produced in the irrigated area.

Usually the initial processing functions are carried on in the local area where farm commodities are produced. They promote community growth, account for increased local earnings and add to the wealth of the area. The importance of this



Workman inside the Wahluke Siphon now under construction.

trade creating aspect of Reclamation development is frequently overlooked.

Rising out of a semi-arid range and wheat country, the Columbia Basin project brought a need for services and facilities that the scattered grain elevators and livestock market outlets could not provide.

To better understand just how much of a change there has been in the Basin, one should go back about 60 years in the history of the area. Until the rush of homesteaders started at the turn of the century, there had been few settlers in the Basin and most of the land was used for grazing. The homesteaders flocked in and established dry-land farms which were successful for a short time. However, intensive cultivation soon lowered the water level in the soil and farmers were forced to rely on rainfall to grow their crops. This source proved to be too scant and most of it came at the wrong time of the year.

Many who stood and watched the first trickle of irrigation water flow to the south could remember the early days when they fought what seemed to be an almost hopeless fight. They thought of the disappointments and the bitterness, of the small elations, and of the constant and exacting hard work required to win this victory.

The project was planned as a family-type development, designed to provide a farm which would yield a living for one family.

The average farm unit on the project is just under 80 acres but there is variation in the individual units. The size depends on the class of land. Those with the best land are smaller than those which have poorer land. This way of laying out the units was adopted so that with all things equal the potential income of each farm would be relatively equal.

When the first modern day settlers came to the Columbia Basin Irrigation project, the land was a raw, desert waste. Sagebrush and rocks and cheat grass, bisected by the raw earth of new canals, was the picture confronting the settler.

Most of the settlers came from the Northwest and West to settle on the project. More than half of them lived in Washington and two-thirds of these in South Central Washington. Almost a third came from Idaho, Oregon, and Montana, and the remaining western states account for another 10 percent. The remainer of about 10 percent came from other parts of the nation and from foreign countries.

About half of the settlers are United States Service veterans but only one in four bought his farm under veteran's preference. There is a requirement under veterans' preference that a settler must have minimum assets of $5,500 but most of them arrived on the project with more than that—the medium figure is about $14,000.

And why did the settler come to the Basin? There are many reasons. Most of those who came from a nonfarm job said they preferred farm work and rural living. Those who had been farming

Grain sorghum production is increasing in the project area.

elsewhere said they felt the project offered them more opportunity. A great many of them came because it gave them a chance to develop a better farm.

A new and enlarging base of irrigated agriculture induces investments and employment. Producers goods and services are needed by farmers to grow crops and livestock as it is by those who process products sold by a farmer. Additional consumer goods and services are needed by the farmers and the processors as well as those who supply them. The mutual interdependence of those supplying the needs of one group and in turn demanding the supplies and services of another have put in motion an economic cycle that reflects itself in increased employment. Such has been the pattern in the Columbia Basin project area.

An upward surge in industrial employment has been experienced in the Columbia Basin project area since the start of irrigation.

Since 1950, local marketing facilities have changed considerably. Dryland grains no longer dominate the project area, having been replaced by other crops and livestock produced on the rapidly expanding irrigated acreage. Nowhere has this change been expressed more clearly than in the expansion of marketing facilities in the area. From 1952 to 1957 about 17 million dollars were invested in 64 processing and marketing plants to handle farm products of the Columbia Basin project. Moreover, four score livestock feeders have found this area a desirable place to finish cattle and sheep.

Processing plant handling onion crop from new lands.

While the network of primary and secondary roads is very necessary in development of the area as part of our economic life, it represents only part of the transportation picture. All types of commercial transportation serve the area.

Livestock promises to be an outlet for a large percentage of the cereal and forage crops grown on the project. It is expected that eventually these crops will occupy about 70 percent of the total croped acreage. During the first few years under irrigation of their farms, farmers have leaned heavily on cash crop production, but a trend toward forage and cereal production for livestock is underway.

Air and water transportation meet on Lake Roosevelt.

This church is typical of the many new churches in the Columbia Basin Project.

Postal receipts correlate highly with general business conditions. Increase in economic activity resulting from the growth of basic industries has reflected itself in a rapid rise in retail sales in the Columbia Basin project area.

Irrigation development has established a new and broader economic foundation and in so doing has enticed people into the area. This means increased investments.

The Columbia Basin project has received attention from private investors during the last decade. Some have started small construction and manufacturing firms; some opened local real estate and insurance businesses; others established specialty shops, motels, or law offices. For every 10 establishments in existence in 1948 in the Columbia Basin project area, there are now 18. This figure does not include the many new businesses which are operated by owners without paid employees.

Fishing, hunting, camping, and all types of water sports are rapidly becoming an important part of the life and economy of the Columbia Basin.

As an example, on opening day of the lake fishing season, April 22, 1956, there were 23,750 fishermen trying their luck in lakes of the Columbia Basin project area. They took 190,000 fish that day.

However, fishing and water sports are not the only forms of recreation benefiting from introduction of water to the area. Family camping has also taken a big upswing in the area. Vacationers who once saw the Basin only when passing through are now spending all or part of their vacations in the area.

The hunter finds more game here each year and the area produces some of the best waterfowl shooting in the Northwest. # # #

4,000 miles of canals and laterals will be necessary to deliver irrigation water to a million acres of arid land.

Continued from page 20

scientists working on greenhouse and laboratory evaluation of aquatic herbicides, on physiological and ecological factors affecting aquatic weeds and on the improvement of research and application techniques. The Agricultural Research Service has made contract research funds available to the Alabama Agricultural Experiment Station for screening of a large number of chemical compounds for effectiveness on aquatic weeds and for tolerance of fish. All aspects of this expanded program are coordinated and integrated with research being done by other agencies to provide the most effective total program in developing improved methods of control.

Many problems on control of aquatic and bank weeds remain to be solved. We need more effective and less expensive methods for controlling submersed aquatic weeds in irrigation canals, especially in large canals with capacities above 100 c. f. s., including those up to 1,000 and even 4,500 c. f. s. in California and Washington where serious aquatic weed problems have developed recently. We need safer and more lasting methods of controlling algae and other submersed aquatic weeds in ponds and lakes. We need less expensive and more effective chemical methods for control of cattail, sedges, rushes, and other rank-growing emergent aquatic and bank weeds. We have promising leads for answering many of these needs, and it seems logical to predict that many improved methods of controlling aquatic and bank weeds will be developed by research in the next few years. # # #

Reprinted from Soil Conservation, Dec. 1958

BOOKS

U. S. D. A. Yearbook Published

The 1958 yearbook of Agriculture entitled *Land* is now off the press. The yearbook gives comprehensive coverage to the land resources of the Nation with an intent to engender better understanding and appreciation of our heritage of productive lands and to foster serious consideration as to the land requirements of coming generations.

The yearbook's many stimulating articles were prepared by recognized authorities in the land resource field. The consensus is universally expressed by the yearbook's contributors on the need for improved land resource planning and utilization to ensure adequate space for food and fiber supplies before our rapidly expanding requirements eclipse the foreseeable capacity of our relatively fixed supply of land.

Chief of the Bureau's Irrigation Division, William I. Palmer, coauthored one of the yearbook articles, *Some new jobs for irrigation.* John B. Bennett, Director of the Technical Review Staff, Department of Interior, was a member of the yearbook committee and collaborated in the preparation of two articles regarding public land. Other contributing authors from the Department of Interior were H. R. Hochmuth and Karl S. L. Landstrom, Bureau of Land Management, and Robert K. Coote and M. W. Goding, Technical Review Staff.

The publication is for sale by the Superintendent of Documents, Washington 25, D. C., at $2.25 per copy.

SOIL-PLANT RELATIONSHIPS
by C. A. Black
JOHN WILEY & SONS, INC., NEW YORK

In this book will be found a thorough analysis of some of the major soil-plant relationships. It has been designed to give an overall understanding of these relationships which can be applied in analyzing and interpreting specific situations. To minimize geographical limitations, general principles and concepts have been stressed and applications are referred to only in the form of examples.

Throughout, the author has emphasized soils as a substrate for plant growth. He sets forth the pertinent facts and ideas about soil properties and behavior but minimizes technical details. Using soils as the point of departure, Dr. Black has been remarkably successful in integrating the properties of soils with the responses of plants—establishing a stronger link between these factors than can be found in any other work of this kind.

LETTERS

Reprint Request

DEAR SIRS: We think the article on handicapped employees of your bureau and how they are leading productive lives is most stimulating. We think it is an excellent example that all governmental agencies might well emulate.

We maintain constant liaison with Governor's Committees on the employment of the handicapped in all the States and Territories. We would like very much to make a national distribution of the article in the November issue of your magazine. Would it be possible for you to supply us with reprints as you did last year?

Your continuing cooperation is deeply appreciated by our committee.

Cordially,
MELVIN J. MAAS,
Chairman, the President's Committee on Employment of the Physically Handicapped, Washington 25, D. C.

We were pleased to make the reprints available.—Ed.

Highway in the Sky

DEAR SIRS: I am editor of the Las Vegas Scene, a weekly tabloid supplement to the Sunday Sun newspaper. I have had the pleasure of reading one of your feature stories—"Highway in the Sky," in the Reclamation Era. It would make excellent general reading material for residents of Southern Nevada, who are quite interested in the progress of the new Glen Canyon Dam.

Whenever you have features of interest to Nevadans, I would be pleased to reprint them in the Scene magazine.

Looking forward to future cooperation with your department, I remain,

Cordially yours,
BOB WARREN,
Editor of Scene.

Reprint permission gladly granted.—Ed.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5047	Crooked River, Oreg	Oct. 14	Construction of Prineville Dam	Keystone Construction Co., Inc., and Associates, Prineville, Oreg.	$2,614,944
DC-5086	Columbia Basin, Wash	Oct. 10	Construction of earthwork, concrete canal lining, and structures for Wahluke Branch canal.	George W. Lewis and Thompson Construction Co., Kennewick, Wash.	234,316
DC-5089	Missouri River Basin, Nebr.	Nov. 10	Construction of earthwork and structures for Culvertson canal, laterals and drains.	Bushman Construction Co., St. Joseph, Mo.	427,450
DS-5092	Fort Peck, Mont	Oct. 29	Three 20,000-kilovolt-ampere autotransformers for Dawson County substation.	American Elin Corporation, New York, N. Y.	289,515
DC-5093	Columbia Basin, Wash	Nov. 6	Construction of earthwork and structures for Block 82 laterals, wasteways, and drains, Royal Branch canal laterals.	Cherf Brothers, Inc., Sandkay Contractors, Inc., and Pheiffer & Pontius, Ephrata, Wash.	1,215,273
DC-5097	Central Valley, Calif	Oct. 21	Construction of earthwork, structures, and bituminous surfacing for relocation of Trinity County road, Rush Creek to Stoney Creek.	O. K. Mittry & Sons, Gardena, Calif.	1,321,341
DC-5100	Washita Basin, Okla	Oct. 17	Construction of Foss Dam	Wunderlich Contracting Co., Palo Alto, Calif.	7,351,557
DC-5101	Missouri River Basin, Nebr.	Nov. 10	Construction of spillways, wasteways, and siphons for Culbertson canal.	Doolittle Construction, Inc., Wichita, Kans.	447,98
DC-5102	Middle Rio Grande, N. Mex.	Oct. 14	Channelization of the Rio Grande, Albuquerque Area	Jackson Construction Co., Rocky Ford, Colo.	204,397
DS-5103	Washita Basin, Okla	Oct. 21	Four 6-foot by 7-foot 6-inch high-pressure gate valves for river outlet works at Foss Dam.	Hardie-Tynes Mfg. Co., Birmingham, Ala.	103,500
DC-5104	Collbran, Colo	Nov. 7	Construction of Southside tunnel with 6-foot 3-inch diameter horseshoe section, schedule 1.	Theo Wood Construction Co., Salt Lake City, Utah.	344,468
DC-5113	Missouri River Basin, Nebr.-Kans.	Nov. 18	Construction of earthwork and structures for White Rock canal, and laterals and drains.	Bushman Construction Co., St. Joseph, Mo.	273,270
DC-5114	Central Valley, Calif	Nov. 26	Construction of railroad and highway siphon for Corning canal.	E-W. Construction Co., Eugene, Oreg.	133,507
DC-5115	Colorado River Storage, Ariz.-Utah.	Dec. 4	Construction of administration building; and garage, fire station, and police building for Page, Ariz.	Sierra Construction Corporation, Las Vegas, Nev.	334,546
100C-350	Yakima, Wash	Nov. 26	Supplemental construction for Kennewick Main canal	L. D. Shilling Co., Inc., Moses Lake, Wash.	118,802
200C-392	Central Valley, Calif	Oct. 2	Clearing 4,855 acres of Trinity Reservoir site, Stuart Fork area and downstream to Trinity Dam.	Union Construction Co., Inc., Missoula, Mont.	906,915

Water is Wealth

U. S. GOVERNMENT PRINTING OFFICE: 1959 O—491307

Construction and Materials for Which Bids Will Be Requested Through March 1959*

Project	Description of work or material
Boulder Canyon, Ariz.-Nev.	One 115,000-hp., 180-r. p. m., 480-foot-head, vertical-shaft, Francis-type turbine with pressure regulator, for Hoover powerplant, Unit N-8.
Do	One 100,000-kv.-a., 16,500-volt, 3-phase, 180-r. p. m., vertical-shaft, hydraulic-driven generator for Hoover powerplant, Unit N-8.
Do	One 168-inch butterfly valve for Hoover powerplant. Estimated weight: 450,000 pounds.
Central Valley, Calif.	Constructing indoor-type Corning canal pumping plant, intake channel, outlet structure, and switchyard, and furnishing and placing 750 feet each of 36- and 60-inch concrete discharge pipe, southeast of Red Bluff.
Do	Constructing about 6 miles of bituminous surface treatment road from Ridgeville to Covington Mill, about 55 miles northwest of Redding.
Central Utah, Utah.	Constructing the 140-foot-high Stanaker Dam, containing about 1,900,000 cubic yards of material, with a crest length of 1,900 feet, and appurtenant structures. On Stanaker Draw, north of Vernal.
Collbran, Colo	Constructing about 22 miles of earth lined and unlined canal with bottom widths varying from 16 to 10 feet, and 6 precast concrete pipe siphons, near Collbran.
Do	One 11,700-hp., 600-r. p. m., 2,430-foot-head, horizontal-shaft, impulse-type hydraulic turbine with governor, shut-off valve, and separate bypass valve for Upper Molina powerplant; and one 6,400-hp., 450-r. p. m., 1,328-foot-head, horizontal-shaft, impulse-type hydraulic turbine with governor and shutoff valve for Lower Molina powerplant.
Do	Constructing 2 powerplants with switchyards, 7 miles of plate-steel pipe penstocks, and an equalizing reservoir, about 40 miles east of Grand Junction.
Colorado River Front Work and Levee System, Ariz.	Constructing about 3 miles of open ditch drain and about 2 miles of 24-inch-diameter precast concrete pipe closed drain, near Yuma.
Columbia Basin, Wash.	Constructing the indoor-type Sand Hollow pumping plant, and concrete outlet transition, and furnishing and placing about 700 feet of 66-inch inside-diameter concrete discharge pipe, northeast of Beverly.
Do	Constructing about 1 mile of concrete-lined lateral, 8 miles of unlined laterals, a concrete pipe siphon and 2 small outdoor-type pumping plants, Block 201, near Mesa.
Do	Gravel surfacing about 42 miles of operating roads, Blocks 85 and 86, near Royal City.
Do	Constructing about 11.5 miles of concrete-lined laterals with bottom widths varying from 8 to 2 feet, in Blocks 21 and 48, near Taunton.
Fort Peck, Mont.	Constructing radio relay stations at Makoshika, near Glendive; Sioux Pass, northwest of Sidney; and Sentinel Butte, east of Glendive.
Little Wood River, Idaho, and Crooked River, Oreg.	Six 4- by 6-foot high-pressure gate valves with hydraulic hoists, two for Little Wood River Dam and 4 for Prineville Dam. Total estimated weight: 216,000 pounds.
MRB, Colo	Reconductoring about 24 miles of the Flatiron-Greeley, 115-kv., wood-pile transmission line, from Flatiron switchyard near Loveland to a point about 6 miles west of Greeley.
MRB, Kans	Constructing about 9 miles of 8- and 6-foot bottom width White Rock Extension Canal, including a 2-mile-long, 42-inch pipe siphon crossing the Republican River, and about 7 miles of 3-foot bottom width laterals, near Republic.
MRB, Minn	Constructing radio relay stations near Erhard and Morris.
MRB, Mont	Constructing about 45 miles of open ditch laterals and about 20 miles of open and closed drains. Helena Valley Unit, near Helena.
MRB, Nebr	Constructing the Merritt Dam, an earthfill structure 120 feet high, 3,100 feet long, and containing about 1,500,000 cubic yards of material, and appurtenant structures, about 25 miles southwest of Valentine.
Do	Constructing about 15 miles of 20-foot bottom width Culbertson Canal, near Culbertson.
Do	Constructing about 25 miles of bituminous surface soil cement access road to Merritt Dam site, southwest of Valentine.
Do	One 5-foot by 6-foot, two 4-foot by 4-foot, and two 2-foot 9-inch by 2-foot 9-inch high-pressure gate valves each with a hydraulic hoist for Merritt Dam. Total estimated weight: 183,000 pounds.
MRB, N. Dak	Furnishing and stringing three 795,000 CM ACSR conductors and two 0.5-inch-diameter steel overhead ground wires for the 165-mile, single-circuit, steel-tower Fargo-Granite Falls 230-kv. transmission line.
MRB, S. Dak	Modifying the Shadehill Dam outlet works stilling basin and constructing a concrete drop structure. On the Grand River about 15 miles south of Lemmon.
MRB, Wyo	Constructing the Gray Reef Dam, an earthfill structure 30 feet high and 800 feet long at the crest, and a concrete-gated spillway. About 2.5 miles downstream from Alcova Dam.
Do	Constructing about 142 miles of 115-kv. wood-pole transmission line from Kortes switchyard, about 35 miles northeast of Rawlins, to Cheyenne substation.
Do	Constructing about 35 miles of 115-kv. wood-pole transmission line from Boysen switchyard to Pilot Butte switchyard, within 40 miles of Riverton.
Do	Completing the Fremont Canyon powerplant and switchyard and extending the Alcova-Fremont 115-kv. transmission line. Forty miles southwest of Casper.
Do	Constructing the Guernsey Rural substation, south of Guernsey.
Paonia, Colo.; Rogue River Basin, Oreg.; Washita Basin, Okla.	Twelve high-pressure gate valves with hydraulic hoists as follows: four 2-foot 9-inch by 2-foot 9-inch for Foss Dam; one 3-foot 6-inch by 3-foot 6-inch, two 2-foot 9-inch by 2-foot 9-inch, and one 2-foot 3-inch by 2-foot 3-inch for Emigrant Dam enlargement; four 2-foot 9-inch by 2-foot 9-inch for Paonia Dam. Total estimated weight: 198,500 pounds.
Weber Basin, Utah.	Constructing the second phase of Willard Dam, an earthfill structure 20 feet high, 15 miles long, and containing about 10,000,000 cubic yards of material. At Willard Bay 11 miles northwest of Ogden.
Do	Constructing 980 linear feet of 12-inch and 2,500 linear feet of 27-inch precast concrete pipelines connecting to the Davis Aqueduct and 2 reinforced concrete stream inlet structures, near Salt Lake City.
Do	Constructing about 1.1 miles of road and 0.6 mile of irrigation ditch, clearing the reservoir area, and fencing about 2 miles. Willard reservoir, about 11 miles northwest of Ogden.

*Subject to change

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Bureau of Reclamation, W. A. Dexheimer, Commissioner

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The Reclamation Era

MAY 1959

IN THIS ISSUE:

New Commissioner of Reclamation
Recreation at Canyon Ferry

Official Publication of the Bureau of Reclamation

The Reclamation Era

MAY 1959 **Volume 45 No. 2**

In this issue . . .

J. J. McCARTHY, Editor

Issued quarterly by the Bureau of Reclamation, United States Department of the Interior, Washington 25, D. C. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, March 3, 1958.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents (single copy). Subscription Price. 50 cents per year; 25 cents additional for foreign mailing.

W. A. DEXHEIMER

FLOYD E. DOMINY

NEW COMMISSIONER OF RECLAMATION

Appointment of Floyd E. Dominy as Commissioner of Reclamation, effective May 1, was announced by the White House on April 3. President Dwight D. Eisenhower appointed Mr. Dominy to succeed W. A. Dexheimer, whose resignation as Commissioner the President accepted with regret.

Mr. Dexheimer, who had served as Commissioner since 1953, had completed 30 years of Federal service—chiefly with the Bureau of Reclamation.

Mr. Dominy, who has been with the Bureau 13 years, had served as Associate Commissioner of Reclamation since March 1958. Prior to that he had been an Assistant Commissioner primarily responsible for Bureau legislative affairs and Chief of the Bureau's Division of Irrigation.

The President, in accepting Mr. Dexheimer's resignation, wrote:

"Dear Commissioner Dexheimer:

"As you have requested, I am accepting your resignation as Commissioner of Reclamation, effective May first. I regret, however, that personal considerations cause you to leave government service at this time, particularly in view of how well you have carried forward the traditions of the Reclamation program.

"The care and development of our natural resources require, on the part of responsible officials, a high dedication such as yours to principles of wise use and prevention of waste. Through your participation in the planning and construction of water resource projects over the past thirty years, you have made a significant contribution to the public good, of which you should be very proud. Your tenure as Commissioner of Reclamation has been the climax of a truly noteworthy career in public service.

"With best wishes for your continued success and happiness."

With his resignation, Mr. Dexheimer submitted to the President a summary statement of the accomplishments of the Bureau since 1953—when Mr. Dexheimer was appointed Commissioner by President Eisenhower. This summary showed that 53 projects or units had been authorized since July 1, 1953, at a total estimated cost of $1,434,151,773. Combined, these features will have storage capacity of 41,533,400 acre-feet, will irri-

Continued on page 38

economical drop structures halt canal erosion

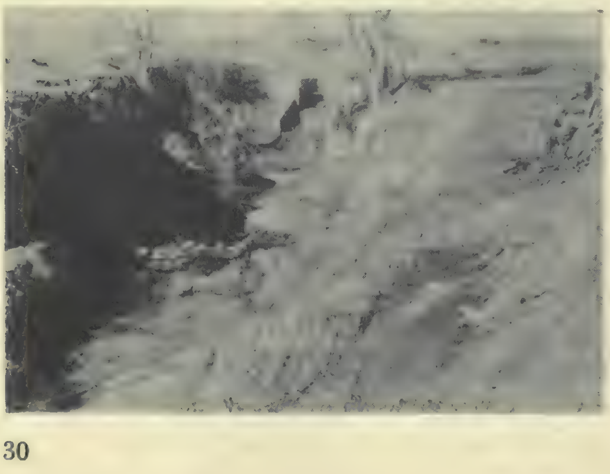
by
THEODORE T. WILLIAMS [1]
DEAN F. PETERSON, JR. [2]

Prevention of further scour and the rehabilitation of a badly eroded irrigation channel was the subject of an investigation completed recently at Colorado State University. Results of the study indicate that bed erosion has been halted in this canal at relatively low cost by the installation of concrete drop structures.

The three-mile-long outlet channel from Thompson Storage Reservoir east of Fort Collins, Colo., having a maximum discharge of 250 cfs, was put in use 60 years ago. Excessive erosion occurred since the channel, which was constructed in alluvial material, had a drop in elevation of 75 feet. The result, by the spring of 1955, was an impressive canyon having a width ranging up to 100 feet, and depth up to 30 feet.

In 1955, although the downstream part of the channel had become fairly stable, the first mile still had a fall of 15 feet. Another 15 feet of fall was absorbed by an old drop structure which had been installed many years ago to protect the reservoir outlet works. This structure, which had been extended and repaired many times, had fallen into a serious state of disrepair, was being undermined, and had reached the point of imminent failure. Erosion of the channel, which was responsible for the loss of considerable irrigated crop land, was aggravated by runoff from surrounding fields, and by a high water table which kept the steep banks saturated to a considerable height. The extent of erosion in the upper reach of the channel is indicated in figure 1, which is a view looking upstream at the old drop structure, and figure 2, taken from the same point, looking downstream. For comparison, figure 3 is a view of the stable lower reach.

Figure 1.—View of Thompson Lake Outlet Channel, looking upstream at the old drop structure, before 1955 construction program. Channel at this location is 30 feet deep and 100 feet wide.



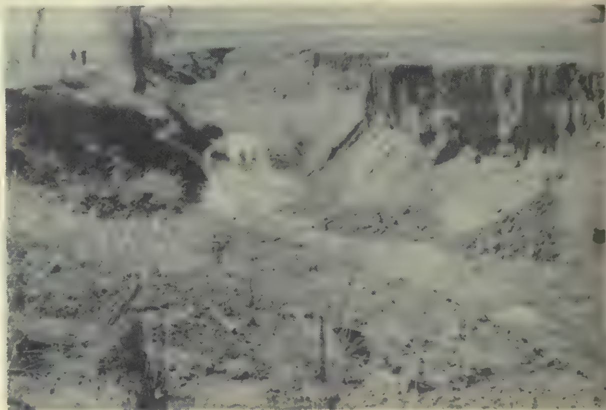


Figure 2.—View of Outlet Channel before 1955 construction program. This view was taken from the same point as photograph on left.

To reduce further erosion of valuable farm land, as well as to protect the reservoir outlet works against undermining, an extensive construction program was instituted in the spring of 1955. The existing drop structure was replaced by a reinforced concrete chute, equipped with a 10-foot ogee crest and modified Saint Anthony Falls stilling basin. This structure, which drops the

[1] Instructor, Civil Engineering, Montana State College.
[2] Dean of Engineering, Utah State University.

Figure 3.—View of lower reach of Outlet Channel. A series of drop structures installed many years ago has maintained this reach in a stable condition.

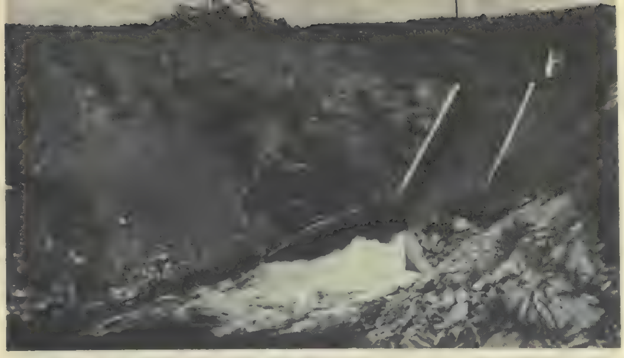


Figure 4.—View of new concrete chute installed spring of 1955. This structure replaced the old drop. The discharge of 125 cfs is one-half the design discharge.

water 13½ feet, is shown in operation in figure 4.

Three vertical overfall drop structures, spaced about 1,300 feet apart, were installed downstream from the chute. Each of these structures consists of a breast wall with 20-foot crest. Vertical, parallel sidewalls extend downstream from the crest a distance of eight feet, and terminate in downstream wingwalls placed at an angle of 45° with the axis of the structure.

Utilizing results of laboratory research investigations at Colorado State University, the overfall drop structures were designed to be equipped with gravel-riprapped or "armorplated" scour holes, rather than with the conventional concrete stilling

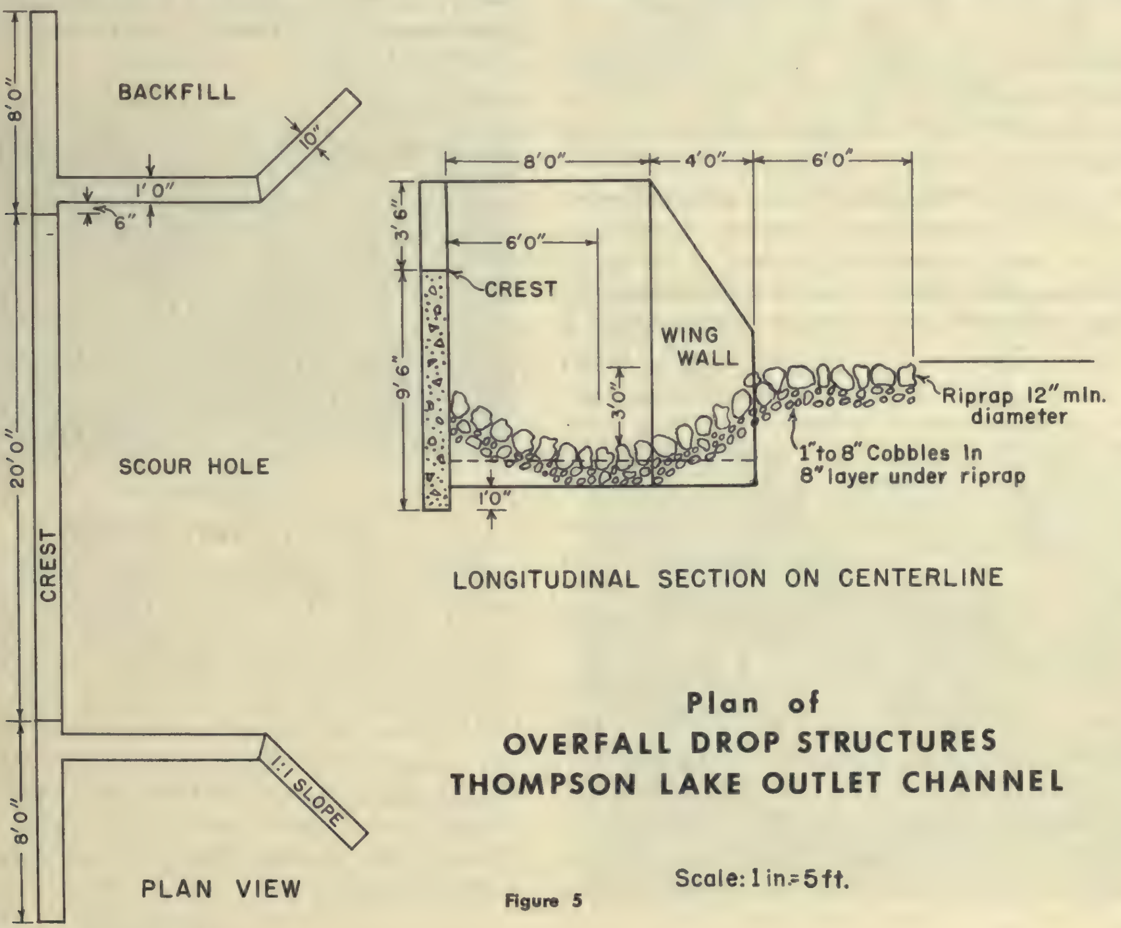


Figure 5

Figure 6.—View of Overall Drop Structure No. 2 shortly after construction in 1955. Energy is dissipated by the pre-formed gravel-armor-plated scour hole. Notice, however, that the coarse portion of the specified armorplating material was not installed.

basins. The laboratory findings indicated that the rate of scour in alluvial material can be significantly decreased if the scour hole is lined with well-graded gravel having a mean diameter larger than that of the natural bed material. It was found that gradation of the armorplating material is more important than absolute size of the particles. Scour hole evolution and protection is currently undergoing further investigation at Colorado State University. Additional information on this work may be obtained from the Colorado State University Research Foundation, Fort Collins, Colo.

The design of the drop structures is indicated in figure 5. Unfortunately, the canal company failed to install the coarse portion of the specified armorplate, so that present armorplating consists only of the light gravel and such gravel materials as have scoured from the natural material. Even so, it has furnished considerable protection against scour. However, the stilling basin performance cannot be adequately judged on the basis of these installations. Figure 6 shows one of the drop structures shortly after its installation, while figure 7 shows the same structure in operation two years later.

Each of the vertical drop structures lowers the water elevation by about 5 feet. There is, therefore, virtually no net drop in elevation between structures, and consequently, no opportunity for bed erosion. In fact, considerable sediment storage capacity is provided upstream from each of the structures.

The rate of bank erosion has not been significantly decreased by the new construction, owing to the factors already mentioned: first, the steep canyon walls adjusting to the angle of repose of the material; second, the entry of drainage waters from adjoining lands; and third, the high water table. The eroded bank material has largely been deposited upstream from the drop structures, and very little has been lost from the channel. Careful measurements of the rate of deposition, however, indicate that the sediment storage capacity will be exhausted in about 1965. After that date, sediment will be transported the full length of the channel, unless a new series of drops at higher elevations, should be constructed to provide more sediment capacity.

Installation of the structures was performed by crews of the Larimer and Weld Irrigation System, owners of the channel, at an estimated cost of $13,000.

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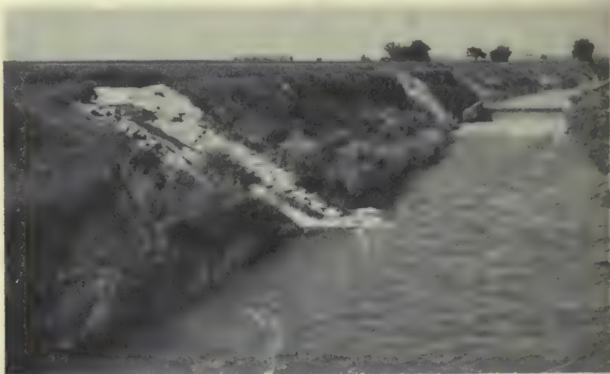
Editor's Note: All the structures were designed by Professor Peterson. Study of the channel behavior before and after installation was performed by Mr. Williams as a research investigation for a Master's thesis.

Figure 7.—View of Drop No. 2 in operation two years after its construction. The discharge shown is 184 cfs. Notice the rock-plastered spillway for discharging wastewater into the channel from adjacent fields.



CANAL SAFETY BOOKLET

A new booklet, Canal Safety, has been published by the Bureau of Reclamation as an additional measure to protect the public, operating personnel, and animal life from the hazards of canals and other water-carrying structures.

Copies of the booklet may be obtained by writing to any Bureau of Reclamation field office. Regional offices are located in Boise, Idaho; Sacramento, Calif.; Boulder City, Nev.; Salt Lake City, Utah; Amarillo, Tex.; Billings, Mont. and Denver, Colo.

Soil Sterilant Control of Grass Type Weeds

by NAT TOLMAN
Chief, Irrigation Operations Division
Bureau of Reclamation, McCook, Nebraska

Men who operate irrigation systems in the higher rainfall belts of the more humid states generally agree that grass type weeds are one of their more troublesome operation problems. Generally, grass weeds are not as serious in the arid States where irrigation first became important. In Nebraska and Kansas, the grass type weeds are very expensive to control but if allowed to grow are very troublesome. There are several different ways operation and maintenance people have tried to handle the grass type weeds: Some irrigation districts try to control them by drowning them with irrigation water. In our area, this is an unsatisfactory procedure because we do not have a crop distribution system or a water supply adequate to keep water in all laterals throughout the irrigation system. Sometimes the grasses are kept in control by mowing, but ordinarily you can only mow the patrol roads and the tops of the laterals and you cannot get the mower down in the bottom of the ditch where the weeds cause the most trouble. Sometimes, attempts are made to get water through weed infested laterals by using shovels and pulling weeds by hand. This is the most expensive method used. The grasses are sometimes controlled by reditching laterals or by using draglines to clean out the choked area. Either of these methods is very expensive. The use of weed burners is sometimes recommended, but again it has been found propane burners are very expensive to operate.

For the last 3½ years, we have been testing and experimenting with grass weed control by use of soil sterilants. There are several different soil sterilants on the market, but our experience has been almost entirely with the DuPont compound, commercially sold as Telvar–W. It was known experimentally as CMU. The first test application of soil sterilant was started in the fall of 1954 and followed with a spring application in 1955. The results were very satisfactory, so a limited field trial application was made in 1956. Sterilant was applied to 20 miles of lateral that year. The results again were very satisfactory, so in 1957 the sterilant was applied to 123 miles of lateral.

It was found that the spring application is the most satisfactory in our area. Sterilant should be applied to a freshly cleaned or burned lateral as soon as the frost is out of the ground in the spring. The results are poor if sterilant is applied to frozen ground or laterals filled with trash and debris. Fall application seems to require

Wm. J. O'Donnell applying soil sterilant to the wetted perimeter of irrigation ditches. Note the new type single jet nozzle which is used for applying the sterilant. The single broad jet nozzle is light weight and does not clog up as often as do the smaller jets. *Photo by L. C. Axthelm.*

Left, view of an irrigation lateral in the Bostwick Irrigation District near Superior, Nebr., which is choked up with grass type weeds. Right, view of an irrigation lateral in the Bostwick Irrigation District near Superior, Nebr., taken at the end of the season to show effects of the wetted perimeter having been treated with soil sterilant. *Photo by G. C. Lynn.*

about one-third more chemical to get the same results.

As to the rate of application, we have tried a number of different rates and have decided that in the silty soils of the Republican and Kansas River Valley of Nebraska and Kansas, control of grass weeds can be obtained with 12 pounds per acre. On the sandy soils, more sterilant is required and about 15 pounds per acre seems to be right. On clay soils, an application of 10 pounds seems to be sufficient. The sterilant is applied with a rather low quantity of water, one pound to 4 or 5 gallons of water makes a satisfactory mix. We try not to apply more than 30 to 50 gallons of water per acre.

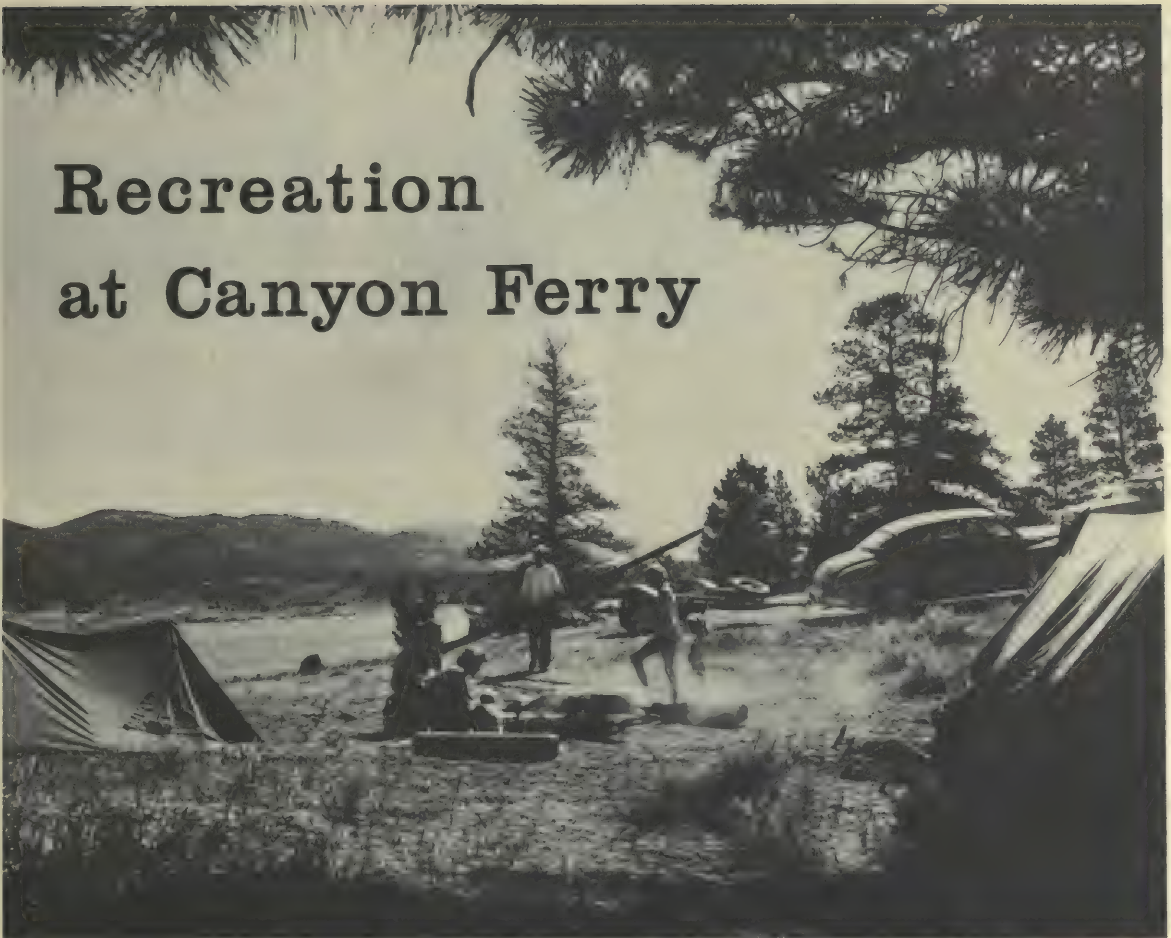
As to machinery, the ordinary truck or jeep-mounted sprayer handles the sterilant mixture satisfactorily provided the sprayer has a *good agitator.* Soil sterilant does not dissolve in water, therefore, it must be kept in suspension by continuous operation of the agitator. To get a uniform distribution, the screens and nozzles should be cleaned after every hour or hour and a half of use. Sterilants are expensive, and, therefore, should be applied with a hand boom and should not be allowed to spread out over areas where a good cover of grass is needed. After the sterilant has been applied to the clean lateral, water should be put into the ditch and allowed to soak the sterilant into the soil, rather than wash it through the lateral.

As to the cost, it is our experience that if you treat 100 or more miles per year, the cost will run about $45 to $50 per mile. The chemical is expensive. In large quantity orders, it costs $3 a pound. Last year in the Bostwick Irrigation Districts, our Superintendent, Gordon Lynn, kept good cost records on treating 123 miles of lateral. His record of costs is as follows:

Chemical–1485# @ $3.00	$4, 440. 00
Labor	1, 036. 00
Mileage and equipment	207. 00
Per mile	46. 20

One of the questions we have tried to answer is how long does the sterilant provide protective control of gasses. Some carry-over effects were obtained but not enough to get along on an every other year basis. I believe that if sterilant is applied 3 years, perhaps we might get along without any application the fourth year or with a one-half strength treatment. It was found that the soil sterilant method of controlling grass weeds is about in line with the cost of 2,4–D on broad leaf weeds or is comparative to cleaning a ditch with machinery but the results obtained through sterilant are more lasting than with burning or the usual cleaning methods. After sterilant has been applied, the laterals do not "choke up" with grass after each little rain shower. We are particularly pleased with the sterilant in that we have had no claims for crop damage by the sterilant washing out on farm lands, nor have we had any personal injuries.

The sterilant has effectively controlled some of our most aggravating grass weeds such as foxtail, fireweed and barnyard grass. ###



Recreation at Canyon Ferry

Canyon Ferry Unit of the Missouri River Basin Project, located on the Missouri River near Helena, Mont., is a multiple purpose dam and reservoir development. Irrigation, the generation of electric power, flood control, municipal water, the creation of recreational opportunities and fish and wildlife conservation activities are the benefits of this multiplepurpose unit. These benefits are all important in varying degree, but on any summer week end there is little doubt in the minds of many Canyon Ferry visitors that recreation is the dominant use of the water surface, shoreline, and the other adjoining lands of Canyon Ferry Reservoir. Fishing, picnicking, swimming, camping, hiking, sightseeing, water skiing—these are the activities that bring thousands of visitors to this scenic mountain lake each year.

Canyon Ferry Dam, 17 miles northeast from Helena, was completed in 1953; the powerplant in 1954. The lake, extending 25 miles from the dam to near Townsend, Mont., has a surface area of 35,200 acres, at elevation 3,800 feet above mean sea level, and is about 4½ miles across at its widest point. The lake has a shoreline of about 200 miles. At the lower end of the reservoir the terrain is rough and rocky, particularly the west shore, contrasting with the placid shoreline at the upper end of the lake where the water spreads out over the valley.

It is about 58 air miles from Canyon Ferry Dam to Three Forks, where the Jefferson, the Madison, and the Gallatin Rivers converge to form the Missouri, a stream that is better known as the Big Muddy for the greatest part of its 2,473-mile-long

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course. At the Three Forks, though, the Missouri is a cold, clear stream whose hurried waters, coming from the nearby slopes of the Rocky Mountain Range along the Continental Divide, soon become a part of the 2,051,000-acre-foot Canyon Ferry Reservoir.

The lands and waters of the reservoir area are divided into three general classes: tracts required for operation and maintenance of the dam and reservoir, recreation areas administered by the Parks Division of the Montana State Highway Commission and the wildlife areas administered by the Montana Fish and Game Department. Under terms of memoranda of understanding, the two agencies agreed to administer, operate, and maintain certain lands and waters for recreation and wildlife. A management plan implements the memoranda of understanding and presents the policies and procedures to be followed by the two State agencies in developing and administering the areas. The management plan was compiled by the Bureau of Reclamation and incorporates plans and information furnished by the two Montana agencies, the National Park Service, the Bureau of Sport Fisheries and Wildlife, and the Bureau of Land Management.

Mr. Ashley Roberts, Director of the Parks Division, has observed Canyon Ferry's recreational growth since the reservoir began to fill. Before even simple facilities could be constructed, hundreds of visitors arrived at the new lake when fishing was first opened in 1955. Scores of tents and trailers dotted the shoreline during that first spring and summer when fishermen sought and found rainbow and Loch Leven trout of such eager, enthusiastic traits that fishermen could only announce loudly and often that it was "phenomenal." While fishing may have since declined somewhat, as compared with that astonishing initial period, other recreation potentials at Canyon Ferry have increased measurably. More than 50,000 persons visited Canyon Ferry in 1958. The reconstructed hard-surfaced highway from Clasoil, a siding on the Northern Pacific Railway which also parallels U.S. Highway No. 10N, to Canyon Ferry, a distance of 9 miles, will bring

Cave Bay on the east shore of the lake, near the dam. Scene of the annual Shrine Fish Derby. Four such derbies have been held since 1955. *Photo by C. A. Knell,* Region 6.

Three of the many summer homes on the east shore of the lake. These homes are located on Magpi Bay, about 4 miles from the dam. *Photos by Edwin O. Wilson.* Right, one of the many pleasure craft seen on a summer week end at Canyon Ferry Lake. Some of these boats are "traveling" boats. A Billings resident will tow his launch to Canyon Ferry Lake. However, most of the craft are owned by residents from Helena, East Helena, Townsend and nearby towns. *Photo by C. A. Knell.*

many more people to the lake during the coming summer, and it is anticipated that about 100,000 visitors will admire and enjoy the lake during 1959. The 9-mile-long section, a part of the Lewis and Clark county road system, was constructed by the Montana Highway Commission.

The county road utilizes the crest of Canyon Ferry Dam to reach the ranches, located on the foothills above the Big Belt Mountains, and also provides access to the many summer cabins and the public day-use areas along the east shore of the lake. The east shore is gentle compared with the west shore where the Spokane Hills approach the lake abruptly. Personnel of the Montana National Guard have a site at the lower end of the west shore and in 1955 they built a short section of the west access road. During the past summer and fall, employees of the Montana Highway Commission bulldozed another 3 miles or so of the new road. The more timid motorist may feel that it is a trail rather than a road but the provisions of an access road to the rugged west shore quickly created a desire for many new cabin sites. Even before the road was built some of the eager potential cabin owners transported material by boat so that construction could begin at once. There are now more than 60 summer cabins at Canyon Ferry, and others are under construction. The Parks Division leases the sites annually at $25 per year. Potential cabin owners must construct the proposed summer homes within 2 years, otherwise the lease is cancelled and the site is made available to someone else. All cabins must be constructed in conformity with established regulations included in the management plan.

Canyon Ferry visitors have enjoyed the use of facilities—tables, fire grates, refuse cans, wells—at four day use areas and one camping area during the three past years and the continuing interest in these areas will require fabrication and placement of new similar equipment before summer's visitation begins. The Parks Division is planning to establish three other camping areas on the west shore.

As provided for in the memoranda of understanding, the two Montana agencies may derive revenues from licenses, permits, leases, or contracts, which they issue, and use such revenue for the administration, development, and maintenance of the areas. Exclusive of the tracts required by the Bureau for the operation and maintenance of the unit, 20 percent of the land is under the administration of the Parks Division, and 80 percent of the land and the water surface is under the administration of the State Fish and Game Department.

There are two places on the lake where boats and docks are available for rent—at Cove Bay on the east shore and Yacht Basin on the west shore. Members of the Broadwater Boat Club have taken over an area near Townsend for development. Other than the site selected and used by personnel of the Montana National Guard, no other organized camps or club sites have been established yet, although several groups have shown interest.

The Canyon Ferry Recreation Association is an alert organization whose members are promoting and developing many activities such as fishing, boating, campsites, access roads, safety regulations and enforcement, and information signs.

Canyon Ferry Dam and Powerplant on the Missouri River near Helena, Mont. Cemetery Island, where some 30 pioneers are buried, once was a hill overlooking the Canyon Ferry community. The island is visible in the left of the photograph. *Photo by C. A. Knell.*

The greater number of the members are from Helena, East Helena, Townsend, and Canyon Ferry, although the membership also includes enthusiasts from Butte, Billings, and Great Falls. It is an enthusiatic association and the activities will do much to assist the Parks Division of the Montana Highway Commission and the Montana Fish and Game Department in carrying forward the recreational potentials of this scenic lake.

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New Commissioner of Reclamation

Continued from page 29

gate 855,875 acres, provide 200,970 acre-feet of municipal and industrial water, and have a generating capacity of 1,380,500 kilowatts.

New starts have been made during the same period on 37 projects or units, with a total estimated cost of $874,985,763. Of this, about $290 million had been obligated.

Recent laws provide for loans to irrigation districts for construction of small projects and distribution systems. To date, 6 loans totaling $23,600,000 have been made. Ten loans totaling $26,200,000 are awaiting funds.

Mr. Dexheimer worked on the construction of the Yakima project in Washington, Hoover Dam on the Colorado River 1929–36, the Bartlett Dam in Arizona, and on Shasta Dam in California from 1938 to 1942.

He had been a career employee of the Bureau of Reclamation since 1928, with the exception of service with the Corps of Engineers in World War II and private foreign work for a year thereafter.

He served from 1942 to 1946 in India and China as Assistant Theater Engineer on the staff of Gen. Joseph Stilwell.

On leaving the military service as a lieutenant colonel, Mr. Dexheimer returned to China as a consulting engineer with the Morrison-Knudsen International Co.

In 1947, he returned to the Bureau of Reclamation at Denver, where he served as Assistant Chief Construction Engineer until his appointment as Commissioner.

A native of Denver, Colo., he was born in 1901. He attended the University of Denver in 1921 and 1922 and was graduated from Colorado State University in 1926 with a degree in civil and irrigation engineering.

Mr. Dominy joined the Bureau in April 1946 as chief of the Allocation and Repayment Branch of the Operation and Maintenance Division. He became Assistant Director of the Division in 1950 and Director in 1953. Under the Bureau's reorganization in December 1953, he became Chief of the Division of Irrigation. In 1957, he was named Assistant Commissioner.

Beginning his professional career as a teacher of vocational agriculture in Hillsdale, Wyo., Mr. Dominy became county agricultural agent in Campbell County in 1934 and continued in that job until the fall of 1938. He became field agent for the Western Division of the Agricultural Adjustment Administration in 1938 and served until 1942, when he became Assistant Director of the Food Supply Division, Office of the Coordinator of Inter-American Affairs. In this position, he was responsible for developing and directing an emergency food supply program in cooperation with various South and Central American countries.

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Ogden Valley's 3 layer water system

Under the Weber Basin project, a unique three-layer water system has been created by the enlargement of Pineview Reservoir in Ogden Valley.

Ogden Valley is located in Weber County, Utah, about 10 miles east of Odgen on the east side of the most westerly range of the Wasatch Mountains. The valley has an area of about 23 square miles and is completely surrounded by mountains. This valley is a fault trough bounded on the east and west by faults and filled to a depth of more than 600 feet with unconsolidated deposits of clay, sand, and gravel. These deposits are of both lake and stream origin. The stream sediments were brought in principally by the three main tributaries entering the valley, the south, middle, and north forks which converge near the west side of the valley. Below this point of convergence, the river enters the steep, narrow and rocky Odgen Canyon. The lake sediments were laid in a small lake that once occupied Ogden Valley and was connected with glacial Lake Bonneville by an arm of water that occupied Ogden Canyon.

The sediments in the valley include about 70 feet of clay, sand, and gravel in alternating layers and is underlain by a bed of varved clay with a maximum thickness of about 70 feet. This clay

Upstream view of Pineview Dam showing spillway and outlet works
Photo by Paul F. Norine.

by JAMES N. OKA, Hydraulic Engineer
Weber Basin Project Office, Ogden, Utah

The Ogden Artesian Wells area prior to inundation by Pineview Reservoir.

layer extends out across the lower parts of the Ogden Valley. Silts and gravels of unknown depths are found under this clay bed. As the aquifer formed by the silts and gravels fill with water, an artesian condition is produced. The recharge area for this artesian basin is the upper part of Ogden Valley where the confining clay layer is absent.

In 1914 Ogden City started drilling wells in the artesian system in the lower Ogden Valley to obtain municipal water. The drilling of these wells continued at irregular intervals until 1933. A total of 51 wells were drilled in what was called Artesian Park. At the present time only 47 of these are in use. They consist of thirteen 4-inch, thirty 6-inch, two 8-inch, and two 12-inch wells with an average depth of about 135 feet. Approximately 15,000 acre-feet of water is obtained annually from these wells with a maximum recorded combined flow of 32 second-feet. By decree, Ogden City has prior rights to the total flow from these wells except that from July 1 to September 30 of each year the withdrawal cannot exceed a daily average flow of 22 second-feet.

In 1935 and 1936 as a part of the Ogden River project, the Bureau of Reclamation constructed the Pineview Dam at the lower end of Ogden Valley in the head of Ogden Canyon. The 41,000 acre-foot reservoir, later enlarged to 44,000 acre-feet, completely inundated the Ogden City artesian wells with about 30 to 400 feet of water.

Before proceeding with the construction of Pineview Dam, a contract was negotiated between the United States and Ogden City. This contract required the United States to cut off the wells, cap them underground, and construct a new collection system. The project included the installation of tees attached to the well casings above which were 2-inch air vent pipes. The water was conveyed through the tees and horizontal pipes to a large collection chamber. From there it was conveyed to the city mains. The contract also gave Ogden City right to drain the reservoir whenever there was trouble or evidence of failure of the collecting system or wells. The reservoir was first drained in 1944 for these purposes. This inspection showed that a number of pipes near the tees close to the well casings had developed leaks. Some of the air vent pipes had developed cracks and one was practically sheared off. It appeared that the damage was caused by vertical movement of the earth over the confined aquifer. Delicate instruments were installed to determine any movement of the earth. The instruments showed a vertical up and down movement which in some cases amounted to three-quarters of an inch.

The filling of Pineview Reservoir created a situation in which the additional load of the weight of the water impounded was super-imposed upon the clay layer. The surface reservoir was

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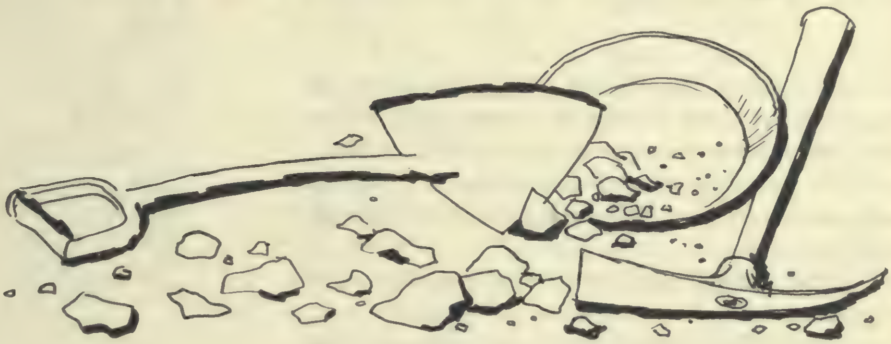
HISTORY in Glen Canyon



The opening last February of a highway bridge across the Colorado River at the Glen Canyon damsite might be called the end of a book: the end of a long record of man's dealing with Glen Canyon on an individual basis. The introduction of the book would tell of the discovery of the canyon by the Spanish explorers Dominguez and Escalante in the historic year 1776. These men and their small company were on their way back to Santa Fe after having made the first comprehensive traverse of Utah and the Arizona strip, when they discovered a difficult ford 24½ miles above Glen Canyon Dam. This, the Crossing of the Fathers, was used intermittently afterwards by Mexican traders, American fur men, and later by Jacob Hamblin, Mormon scout and missionary on his first trips to the Hopi villages which began in 1895. After 1872, when John D. Lee put a ferry in operation at Lee's Ferry, 15 miles below Glen Canyon Dam, the Crossing of the Fathers was little used—except by the Indians.

When the United States determined to round up the Navajo Indians in 1863 and place them in the concentration camp at Bosque Redondo, a good many of them eluded Kit Carson and the Army by moving in with the Paiutes living in the canyon lands bordering the Colorado River in Utah. From there the Navajos crossed the river to raid the Mormon settlements from time to time until peace was negotiated with them by Jacob Hamblin in 1874. To the Navajos and the Paiutes, like the ancient Pueblos who preceded them by centuries, Glen Canyon and its many tributaries, together with San Juan Canyon, offered a secure home which they came to know intimately. The deep canyon was scarcely a barrier. The Indians reached the river bottom lands at many places and they forded the river at many places, including the Crossing of the Fathers, during low water or on the ice in cold weather. These were the beginnings.

The exploratory expeditions undertaken by John Wesley Powell, 1869–1872, focused interest on the canyons of the Colorado and it is from that time that the intensive history of Glen Canyon begins. Powell demonstrated that the canyons of the Colorado were passable, and the Wheeler and Hayden surveys publicized the adjacent country.

Government explorers were followed by settlers and miners. During the 1870's Mormon frontiersmen worked their way around the base of the High Plateaus where they established small farming communities like Kanab, Paria, Cannonville, Escalante, and Hanksville. This at the same time that discoveries of gold and silver on the headwaters of the San Juan River brought thousands of miners into southwestern Colorado where they promptly disturbed the Ute Indians. In order to forestall another Indian outbreak on the southern border and also to expand the frontier of settlement, the Church of Jesus Christ of Latter-Day Saints sent a colonizing mission to the San Juan country. This was the famous expedition which crossed Glen Canyon at Hole-in-the-Rock. These courageous Mormon trekkers spent altogether 6 months on the trail before they arrived at Bluff on the San Juan River in April, 1880. They had crossed some of the most difficult terrain for wag-

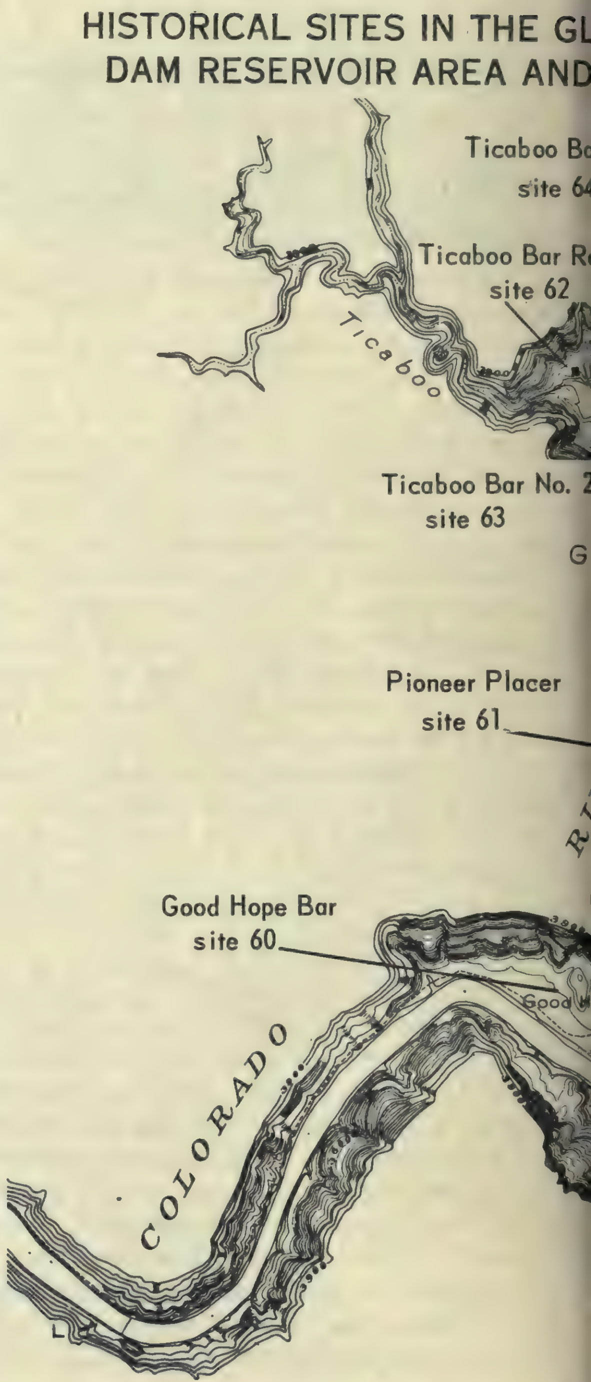
by C. GREGORY CRAMPTON, Professor of History and Director of Historical Research, Upper Colorado River Project, University of Utah.

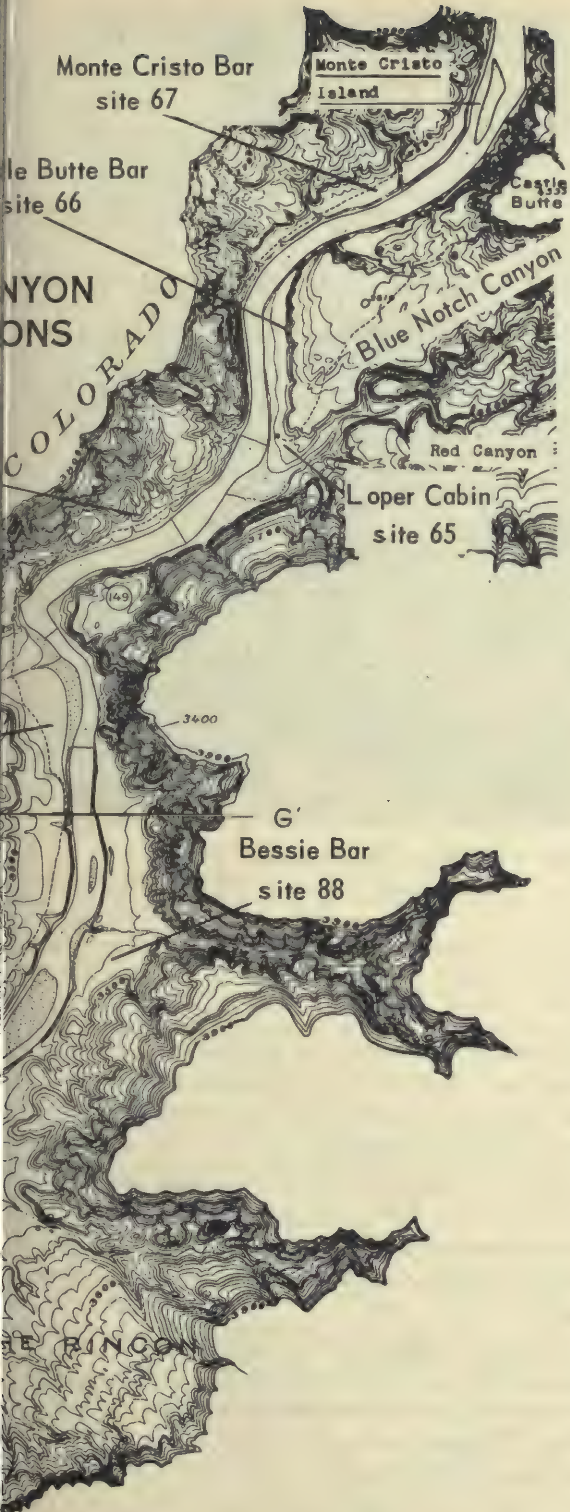
Map showing the location of historical sites along an 11-mile stretch of the Colorado River in Glen Canyon. This area was intensively worked during the gold rush in the canyon from 1883 to about 1910.

ons anywhere in the United States and the road they built may still be seen in many places. The most spectacular construction is at the Hole-in-the-Rock through which wagons were driven to reach the river a thousand feet almost directly below.

The discovery of gold opens another—and the longest—chapter in the history of Glen Canyon. About 1883, Cass Hite, a prospector from the San Juan Country in Colorado, was told by the Navajo Chief Hoskinnini that there was gold in the sands of the banks along the Colorado River. Hite found pay dirt at Dandy Crossing where the settlement of Hite is located and later at the mouth of Ticaboo Creek downstream a few miles where he built a cabin. Hite's placer gold mining operations attracted others to the Canyon, including the officers of the Denver, Colorado Canyon, and the Pacific Railway Co., organized in 1889 to build a railroad from Colorado to the coast. The company planned to avoid the expense of moun-

Professor David E. Miller examines an engine built along the river at New Year Bar to pump water for mining purposes.





tain construction by using the natural grade of the canyons of the Colorado River!

The idea of a canyon railroad was abandoned after two surveys were made. However, when gold was discovered in the early 1890's in the Abajo Mountains, La Sal Mountains, Henry Mountains, and the San Juan River, and considerable numbers of men rushed into these regions adjacent to Glen Canyon, another company was organized by the Chief Engineer, Robert B. Stanton, for the purpose of mining in the canyon. Stanton in 1898 staked out nearly all of the river bars in Glen Canyon not already claimed by others and then he assembled an 80-bucket gold dredge on the Colorado above Bullfrog Creek. The company went bankrupt after 6 months' operations in 1900.

Stanton was not alone in the canyon. Hundreds, perhaps thousands, of men prospected the whole length of Glen, the canyons above and all the tributaries in the decade between 1890 and 1910. They found gold all of the way through Glen Canyon from the mouth of the Dirty Devil to Lee's Ferry but practically nothing was found in the tributary streams. The exception was the canyon of the San Juan where diggings were located at several places below Mexican Hat.

Gold hunting in Glen Canyon was difficult

Don R. Mathis climbs steep roadway blasted from sandstone cliff by R. B. Stanton to haul in heavy machinery for a gold dredge installed in Glen Canyon in 1900.

Part of the cabin occupied by Bert Loper, miner and river runner, who lived in Glen Canyon many years.

All photos by the author.

business. The gold, seldom found in pockets, was extremely fine and difficult to extract from the sand and gravel. The canyon with its precipitous walls and deeply-incised tributaries was difficult to traverse. Roads were blasted in sandstone cliffs to haul in heavy machinery. Steps were cut in steep slick rock slopes to make horse trails, and various kinds of craft from barges to skiffs were used to navigate the river. Cabins were built, small plots of land were irrigated to raise food, and a post office was established at Hite to keep the canyon miners in touch with the world. When World War I opened, gold operations virtually ceased only to be revived briefly during the depression of the 1930's.

The later history of Glen Canyon is varied. An oil boom in the 1920's led to considerable prospecting and at least four wildcats were drilled in the canyon floor at the Waterpocket Ford. Oil prospecting continues today in upland regions of Glen Canyon. There was a flurry of uranium prospecting after World War II especially in the upper part of the canyon but the profitable working mines have been found on the tributary streams some distance above the level of the future reservoir in Glen Canyon. Other diverse activities in the canyon include trapping, trade with Indians, farming, stock raising, and flights from justice.

The scenic beauty of Glen Canyon has attracted a large number of tourists every year until it is now one of the most well-traveled streams in the United States. The gold miners of the earlier years became thoroughly familiar with the natural features of the canyon lands but they were not very articulate about them—moreover, scenery got in their way'—so they were all rediscovered by later travelers. The first approaches were mainly by land and on the eastern bank where guides like

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WATER REPORT

The irrigation water supply outlook in the western United States is fair to good in the north, poor in the south and southwest. There are a few areas of very heavy snowpack near the Canadian border in northern Idaho and western Montana. At the other extreme, there is a widespread deficiency of seasonal snow accumulation over southern Colorado, Oregon, Utah, and California as well as all of New Mexico, Arizona, and Nevada. For intervening areas snowpack is near normal.

Relatively high runoff during the 1957 and 1958 water years provided substantial carryover storage, particularly in larger reservoirs. Water supply outlook in many areas includes the effect of storage. Where snowpack is normal, storage will provide supplemental and late season water supply. Where snowpack is low, stored water will tend to alleviate a disastrous shortage during the 1959 season. Again this year, the need for storage facilities to carry water from good to poor seasons, particularly on tributary streams, is apparent.

With average or less snowpack in the mountains, it follows that very little probability exists for damage from high streamflows resulting from snowmelt. The only reference to this possibility is made for the Blackfoot and Clark Fork rivers in western Montana.

Forecasts of 1959 irrigation water supply and general water supply conditions in the West are based on April 1 measurements by the U.S. Department of Agriculture, Soil Conservation Service and many cooperating organizations[1] on about 1,300 snow courses and 100 soil moisture stations. The amount of storage in nearly 250 reservoirs also is considered in appraising the water supply outlook. The relative demand for water in an area is recognized as an integral part of the general water supply situation.

The purpose of water supply forecasts is to provide advance information on prospective water supplies in order that plans may be made for the best use of water by individual as well as group users. In this report only general areas and major tributaries are considered.

In the Missouri River Basin streamflow will range near normal with 120 percent of normal in

[1] The Soil Conservation Service coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal Bureaus, various departments of the several States, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that State, contributed the California figures appearing in this article. The Water Rights Branch, British Columbia Department of Lands and Forests has charge of the snow surveys in that Province and likewise contributed the information here for British Columbia.

by **HOMER J. STOCKWELL**, Snow Survey Supervisor, Soil Conservation Service, Fort Collins, Colo., and **NORMAN S. HALL**, Snow Survey Leader, Soil Conservation Service, Reno, Nev.

some upper Missouri tributaries, and down to 60 percent of normal in the Wind River drainage in Wyoming. Water supplies along both large and small streams should be adequate, but not plentiful. The headwaters of the North and South Platte rivers in Colorado and Wyoming have a normal or better snowpack. Soil moisture in irrigated areas is good. Carryover storage is well in excess of normal in both public and privately owned reservoirs for agricultural and municipal use. A similar outlook prevails for the Arkansas River Valley. The irrigated area of eastern Colorado and Wyoming and western Nebraska and Kansas has a reasonably good water supply outlook, almost comparable to the 1957 and 1958 water years.

Water supply outlook for the Rio Grande is poor in both Colorado and New Mexico. April 1 snowpack is near a minimum of record and mountain soils remain dry. Storage in Elephant Butte is near average, but the outlook remains poor because of minimum prospective inflow. In the eastern New Mexico projects at Tucumcari and Carlsbad, the water supply outlook is good with well above normal carryover storage.

Surface runoff prospects are poor in Arizona with no snow remaining as of April 1. Carryover storage is near normal, which will provide an average surface water supply on the Salt River and its tributaries. Storage is not sufficient to meet normal demands for the Gila and Little Colorado Rivers.

The general shortage of winter snow extends into the San Juan Basin in Colorado and the southern two-thirds of Utah. Streamflow in this general area of the Colorado River and Great Basin will range from about 30 to 60 percent of normal. Heavy demand areas without storage will be critically short. Water supply outlook in northern Utah is somewhat better. Streamflow there is forecast from 75 to 100 percent of normal with above average carryover storage.

Streamflow in Nevada will be extremely low, near 10 percent of normal on the Humboldt and 50 percent of normal for streams from the east slope of the Sierras. Central, eastern, and southern Nevada have a short water season in prospect.

In the Columbia Basin water supplies are generally adequate for Washington, northern Idaho, and western Montana. Tributaries in western Montana have a near record snowpack. In southern Idaho snowpack is light. Reservoir storage can make up the shortage of natural streamflow, but rivers without storage are faced with a serious shortage of water.

Snowpack on Columbia River tributaries in Oregon has been less than normal. Streamflow forecasts range from a low of 17 percent on the Owyhee to near 100 percent on some smaller streams in southwest Oregon. Most streamflow forecasts are in the range of 60 to 90 percent of normal.

In California, the winter snowpack has been deficient. Water supply outlook varies from fair in the north, where near normal runoff is expected, to poor in the south, as indicated by forecasts of less than one-half of normal. Reservoir storage will provide the difference between poor and fair supplies in many areas.

Forecasts for the the major streams of the West for the April–September 1959 period as compared to normal, are as follows:

Columbia River at The Dallas, Oregon
96,500,000 ac. ft. or 99 percent of normal

Missouri River at Fort Benton, Montana
3,341,000 ac. ft. or 99 percent

Colorado River at Grand Canyon, Arizona
7,300,000 ac. ft. or 73 percent

Sacramento River inflow to Shasta Reservoir, California
2,000,000 ac. ft. or 85 percent

San Joaquin River below Friant Reservoir, California
745,000 ac. ft. or 55 percent

Rio Grande at Otowi Bridge, New Mexico
280,000 ac. ft. or 33 percent

This analysis is again presented in the *Reclamation Era* through the courtesy of the authors, and Mr. R. A. WORK, *Head, Water Supply Forecasting Section.* In the following paragraphs the water supply outlook by States is briefly reviewed.

ARIZONA—An exceptionally dry March has been added to an already deficient moisture year. As a result, the January through May runoff in the State will average only 20 percent of normal. However, reservoir storage is 84 percent of average. The water supply for the land served by reservoirs on the Salt and Verde Rivers is adequate for this year. The available water in the San Carlos and Carl Pleasant Reservoirs will be short of a full supply, but will not require drastic curtailment of normal cropping operations. In the limited areas where only direct diversion of spring runoff is available, the water supply will be short.

CALIFORNIA—The California Department of Water Resources reports that the water supply outlook is for below average runoff in all areas of the State. Snowmelt runoff from mountainous areas will vary from near minimum of record in the southern San Joaquin Valley, where extensive agricultural development exists, to near average in the extreme northwest portion of the State where most of the water must be wasted to the sea because of geographical limitations of the region.

Precipitation was below average in all but portions of the extreme northern section of the State where near or slightly above average amounts were recorded. Snowpack was also below average in all but the same areas. A very dry, warm March contributed little to the snowpack and in many cases caused premature snowmelt with resultant depletion of the lower elevation snowpack. It is estimated that the snow-stored water is about 60 percent of average for the State as a whole. Water stored in surface reservoirs is about 105 percent of average for April 1.

Water supply conditions in the area south of Sacramento will limit agricultural use where carryover or importations are not adequate. Water will be available for municipal and industrial use in virtually all areas of the State.

COLORADO—The water supply outlook is relatively good for the Platte and Arkansas Rivers east of the front range in Colorado. Mountain snow accumulation to April

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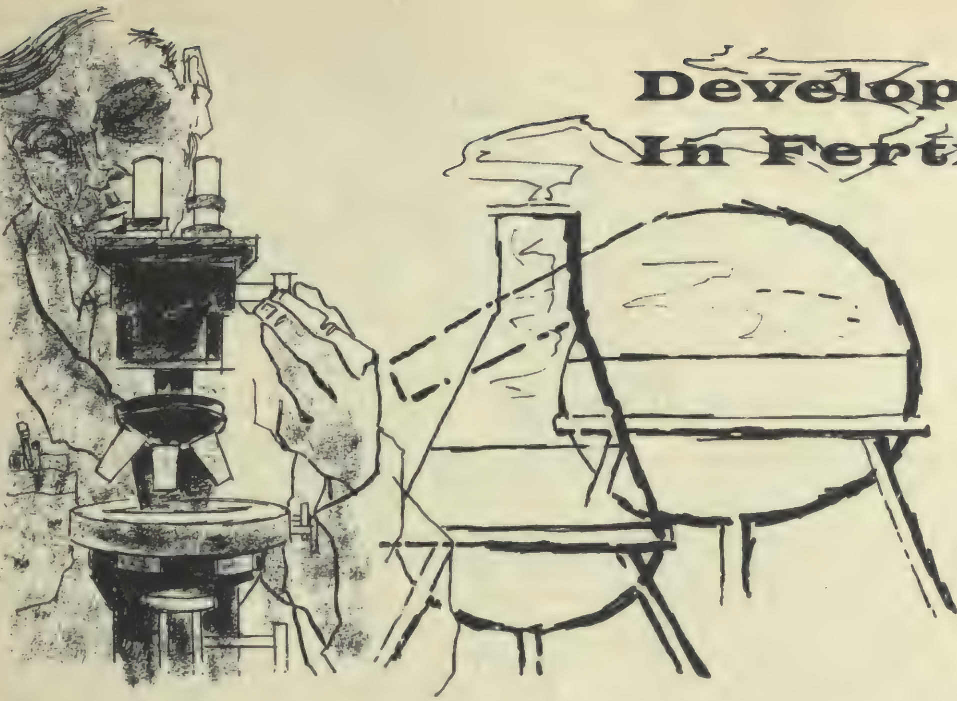


New Developments In Fertilizers

by

VINCENT SAUCHELLI
Chemical Technologist
National Plant Food Institute

Like so many other industries in our economy, the fertilizer industry, since the late 1930's has experienced the urge for new plans and activities to meet the requirements of greater consumer demand and lower unit cost of production. The tempo of change received new impulses during and immediately after the recent war period and the fertilizer industry has remarkably met the pace set by our new mechanized powered agriculture which it serves. The farmer was required to step up his production of food, feed and fiber crops for war exigencies. He discovered he could use fertilizer as a new hired hand and by its use boost his crop yields and net profit.

The stepped-up demand for commercial fertilizer coupled with urgings from Federal Government agencies stimulated the fertilizer industry to build new productive capacity. As a consequence capacity has outstripped demand. This will be better understood by referring to some supporting statistical data.

Synthetic ammonia has become the chief source of nitrogen. In 1939 the total United States production was 245,000 tons and rated capacity was about 380,000 tons per annum. By the first of 1958 the total United States capacity was about 4,190,000 tons and production upward of 3,000,000 tons. This is a spectacular growth, perhaps more spectacular than the tonnage of any other product of the chemical industry.

Ammoniation

One of the important new developments in the manufacture of compound or mixed fertilizers is the use of ammonia and the ammoniating solutions in the production of the granulated type of fertilizer. Granulation and ammoniation seem to have developed side-by-side and represent a radical change in the technology of fertilizer. These developments have altered the character of the industry by changing it from a more or less blending or dry-mixing operation to a chemically-engi-

neered, quality controlled industry requiring highly skilled personnel in production, sales and management.

Ammoniation of fertilizer mixtures began in earnest about 1937. The ammoniating solutions consist of varying percentages of ammonium nitrate, or urea or both in a solution of ammonia. The free ammonia in these solutions reacts with the superphosphate and free acid present in the mixture. The result is an ammoniated phosphate and the effect on the physical condition of the product is very favorable.

The usual method of producing a mixed fertilizer to furnish two or more major plant nutrients is by the so-called batch method; that is, weighed amounts of the solid, raw materials supplying nitrogen, phosphorus and potassium plus other desired nutrients, are put into a rotary drum mixing unit and thoroughly blended. To make many mixtures of relatively higher nitrogen content it is now customary to introduce a specified volume of one of the ammoniating solutions. The phosphorus is furnished by normal or triple superphosphate and, in some grades, by added phosphoric acid. Solid nitrogen carriers commonly used are ammonium sulfate, ammonium nitrate, ammonium phosphate and urea. These raw ingredients are carefully selected for compatability and mixed in the drum mixer after which the blended material is conveyed to storage bins. Each mix is a batch. The free ammonia in the nitrogen solution reacts with the superphosphate and free acid. Heat is generated by this reaction and advantage is taken of this for drying the mass.

Granulation

The method of granulating a fertilizer to make a free-flowing, homogeneous product is a modification of the batch mixing system. The current, favored system utilizes selected raw materials which will granulate easily. The operator finds and uses certain soluble salts in the mixtures which will develop under high temperatures the proper volume of liquid phase with the minimum use of water. In all modern granulating plants the ammoniating and granulating operations proceed in a continuous manner and not in batches. Great

Drilling winter barley and banding fertilizer in one operation on land irrigated under south half S—4 sprinkler system. ***Photo by S. B. Watkins.***

W. J. Walters loads seeding machine with oats for seeding on land irrigated under the border dike method of irrigation. The border dikes can be seen in the background.

skill is required to devise formulations of raw materials which will provide the correct combination of liquid phase and generate the right amount of heat of chemical reaction. This really constitutes the fundamental control in the process.

The first commercial production of granulated mixed fertilizer and of superphosphate took place in the fall of 1935. It was not until 1950, however, that granulation became established in the United States. Since then new granulating plants have been built at a rapid rate and at the beginning of 1958 the number had increased to 171. Of the total number, 162 granulating installations are located in the Middle West. The total annual production of granulated fertilizers is currently about 3 to 4 million tons. The trend is definitely toward the production and use of granulated mixed fertilizers and materials.

Phosphates

Reference was made to the spectacular growth of the synthetic ammonia industry. No less remarkable has been the expansion of production facilities for making superphosphates. Capacity far outstrips demand. At present the estimated total capacity of this country is 4,600,000 tons, basis P_2O_5, and consumption a little over half this amount.

The same story holds good for the American potash industry. The present estimated total productive capacity is about 2,500,000 tons, basis K_2O, per annum. This represents a surplus capacity of about 25 percent over actual consumption.

Test plots operated by the State Experiment Station on the Huntley Reclamation project.

The fertilizer industry serves a fundamental need in our economy. Its primary objective is to help the farmer get a reasonable profit from his operations. It is an established fact that commercial fertilizers are an indispensable tool in modern agriculture. They serve, when properly employed, to make poor soils fertile and fertile soils more fit to grow the newly developed high-producing crops varieties profitably. Industralized farming must constantly strive to reduce the crop unit cost of production. In this objective commercial fertilizers are the key factor. ###

Ogden Valley

Continued from page 40

alternately filled and emptied each year causing an alternate increase and decrease of pressure on the clay bed. As this clay bed is essentially impervious the alternating pressure change causes a slight alternating movement in the clay bed. With the added weight, there is also a certain amount of compressibility of the aquifer which contracts when water is withdrawn from it and expands when water is added.

Beginning in 1955 as a part of the Weber Basin project, the Bureau of Reclamation started construction work to raise Pineview Dam an additional 29 feet. The reservoir capacity was to be enlarged from 44,000 acre-feet to 110,000 acre-feet. Before the impoundment of water by the enlarged reservoir, it was considered necessary to correct the problem of future breaks in the pipes tapping the artesian water.

It was believed that the additional head on the reservoir and greater drawdowns due to the enlargement would increase the magnitude of fluctuations in the artesian pressures of the underground aquifer and cause further movement of the impervious clay bed.

To remedy future breaks in pipes it was necessary to make flexible connections to compensate for the ground movement. A 25 foot by 25 foot by 10 foot deep excavation was made around each well; the well casing being near one edge of the hole. About 12 to 16 well points were driven into the ground around the excavation to a depth below the bottom of the hole. These well points were connected to an 8-inch line laid on top of the ground. By means of a vacuum pump, water was pumped through the well points and delivered to the stream bed which carried it away. By this method, the excavation was kept free of water while the job of modifying the wells was in process.

Ogden City Artesian Well No. 36 after excavation, with modification and repair about to begin.

Ogden City Artesian Well No. 36 showing water gushing from break at tee.

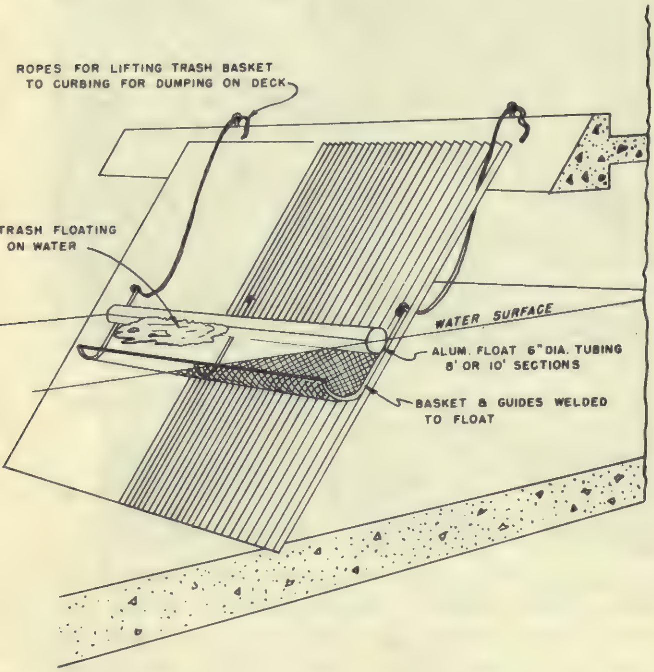
The horizontal pipeline attached to the well casing was then cut in two places, one near the vertical well casing and the other, 10 to 15 feet away. Two dresser couplings were used to reconnect the lines, making them flexible.

To make the air vent lines flexible, lead connections were inserted near the well head. In all, 24 wells required repairs but 45 were modified as described. This program of modification was completed in December 1956.

It is believed that this modification of the wells will solve the problem of the breaks in the pipes. This, however, will be determined after the enlarged reservoir is filled and emptied several times under actual operation.

With completion of all construction required in raising of the dam and modifications of the artesian wells, the three layer system is now ready to begin operations. ###

Floating Trash Basket



This all aluminum floating trash rack is light in weight and may be altered to fit the structure it is to be used on. The baskets are built in short lengths to facilitate the lifting of sections containing the most trash, leaving the others to be cleared at a later date. Designed by Lester F. Beal, Engineering Draftsman, Bureau of Indian Affairs, Portland, Oregon.

Your Magazine

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

"GET ACQUAINTED" COPIES

If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D. C. We shall be glad to send them copies of back issues.

History at Glen Canyon

Continued from page 44

John Wetherill and Zeke Johnson packed tourists in with horses and mules. Now the canyon rims may be reached by four wheel driven vehicles at many points, but most tourists prefer to see the canyon by water. Their numbers will increase as the waters of the reservoir bring new and enchanting areas into view.

This brief review will indicate that, far from being an isolated region remote from the currents of human activity, Glen Canyon has been the very center of a historical panorama including Spanish Padres, Mormon scouts, Government explorers, prospectors, outlaws, trappers, and tourists. And now a new era begins as the Nation through reclamation adapts the power generated in Glen Canyon to wide public use.

The building of this dam means that a good many historical values will be lost as the waters of the Colorado are gradually impounded. A program of historical research by the University of Utah, sponsored by the National Park Service, is under way to see that an adequate record is made of the canyon's history and to prevent the loss of valuable relics. Field studies in combination with library research have enabled us so far to locate and identify over a hundred historical sites in the reservoir area of Glen Canyon alone. It is expected that the work will continue until we have written the complete history of Glen Canyon.

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Glen Canyon from the trail to Klondike Bar—one of the placer mining operations along the river.

Continued from page 46

1 is normal or better, soils in irrigated areas are moist, and surplus storage carried over from the past two heavy streamflow years will help to provide a supplemental supply should the summer months be dry. A substantial amount of water is stored in the larger reservoirs, including John Martin on the Arkansas, in the Colorado-Big Thompson, and in Denver municipal reservoirs on the South Platte. Streamflow on the Lower Platte was above normal during the winter, so reservoirs will fill by the start of the irrigation season.

For northwestern Colorado, including the Upper Colorado River, streamflow will be slightly less than normal, but adequate to meet all but late season demands. Some shortage probably will occur on Gunnison River tributaries.

Seasonal snowfall has been light on the San Juan, Dolores, and Rio Grande drainages. Streamflow for 1959 on all of these streams will range near one-half of normal. Severe shortages, comparable to the 1954–56 period, are in prospect. The only favorable item is higher groundwater levels in San Luis Valley as compared to these drouth years. The use of groundwater again will be extensive. The shortage will be most severe on the Dolores River.

IDAHO—The Kootenai River in northern Idaho frequently poses a serious high water threat to all interests along its flood plain, but is forecast to flow normally this year. Streams originating in Montana and flowing into Idaho are predicted to have excellent water supplies for 1959.

The snowpack is light along rivers in southern Idaho so the outlook is for a low water supply. Reservoir-stored water can make up for deficiencies in natural streamflow, but on those rivers without adequate storage, a serious water supply shortage is in prospect. Dry soils beneath the light snowpack indicate an early recession in streamflow during the irrigation season. Carryover storage from 1958, however, is excellent on all rivers, and will give major southern rivers, such as the main stem Snake, Boise, and Payette, a normal supply when considering the reservoirs involved.

KANSAS—The prospects for irrigation water along the Arkansas River are relatively good. Soils are in good condition. Storage in John Martin and the Great Plains reservoirs in eastern Colorado, along with prospective streamflow indicates a good water supply in this area for 1959.

MONTANA—The water supply outlook for Montana is fair to excellent for the 1959 irrigation season. Missouri River Basin streams are expected to flow from 80 to 114 percent of average with Columbia River tributaries forecast at 109 to 166 percent of average. An exceptionally heavy snowpack covers the headwaters of the Swan and Blackfoot rivers and Mission Range with measurements all above previous records covering 20 years. This is likely to cause high water on the Blackfoot and Clark Fork rivers above Missoula and also in the Swan River to Big Fork.

Soil moisture conditions under the snowpack and in irrigation areas are relatively good. Irrigation and power production reservoirs contain slightly more than average carryover storage this April 1.

NEBRASKA—Water supplies along the North Platte in Nebraska are expected to be very favorable in 1959. Storage in the channel reservoirs in Wyoming serving the North Platte project contain a normal amount of water credited to the western Nebraska irrigated area. Snowpack in the mountains of Colorado and Wyoming is above normal and inflow to the reservoirs is forecast at near average. Soil moisture in the irrigated areas is very good as a result of recent storms. Reservoir storage in the state serving the main Platte Valley is also much above normal. Streamflow last year was high in this area.

NEVADA—Water users who do not hold reservoir storage rights are faced with critically short supplies. Fortunately, reservoir storage is above normal, and those who do have storage rights can expect adequate, but limited supplies.

Forecasts on the Owyhee River in northern Elko County are for about 20 percent of normal streamflow, 12 percent on the Humboldt River at Palisade, and about 50 percent on the Walker, Carson, and Truckee-Tahoe. Central, eastern, and southern Nevada, with no reservoir storage, face a short-water season.

April 1 storage in seven important reservoirs was 78 percent of capacity or 120 percent of the 1938–52 normal. Lake Tahoe stores 563,000 acre-feet at elevation 6227.63 above sea level, and is not expected to approach the legal maximum. Rye Patch Reservoir on the Lower Humboldt is 123 percent of the April 1 normal. Bridgeport and Topaz reservoirs on the Walker River system are full.

NEW MEXICO—Following two good water years, a severe shortage of irrigation water is in prospect for the Rio Grande through New Mexico. Snowpack is less than 50 percent of normal on the watershed in Colorado and New Mexico. Above Elephant Butte, water shortage will be similar to that experienced in the 1953–56 period. The outlook below Elephant Butte in New Mexico and Texas is improved because of over 1,000,000 acre-feet in storage. However, with minimum inflow forecast to Elephant Butte the outlook is considered fair to poor in this area.

Although streamflow from snowmelt will be negligible into Conchas Reservoir on the Canadian River and Alamogordo Reservoir on the Pecos River, the water supply outlook is relatively good. Storage in these reservoirs is well above average and will provide a reasonably adequate water supply.

OKLAHOMA—With practically no precipitation on the Altus project in Oklahoma since the fall of 1958, the water supply outlook is poor. Soils are very dry. Storage in Altus is about 150 percent of normal, but unless spring precipitation is normal or better, the water supply will not be adequate.

OREGON—Water content of the mountain snowpack in Oregon averages only 61 percent of the April 1 normal. The soil mantle under the mountain snowpack is still only partially wet except on the main Cascades and in the northeastern Oregon counties where moisture penetration is satisfactory. Soils in southeastern Oregon are exceptionally dry.

Stored water in 22 irrigation reservoirs is 110 percent of the average April 1 amount. Good carryover supplies from last year help to make the outlook this year more favorable. Reservoired water will literally "save the day" for many areas this season.

Forecasts of April–September runoff range from lows of 17 and 26 percent normal on Owyhee and Silvies Rivers to near 100 percent on the Applegate, Illinois, and Wallowa Rivers. Other forecasts for the April–September runoff (in percentages of normal) are as follows: Malheur River, 55; Burnt, 60; Powder, 68; Grande Ronde, 68; Umatilla, 86; Walla Walla, 77; John Day, 76; Crooked, 48; Deschutes, 74; Willamette, 85; North Umpqua, 85; Rogue, 69; Klamath Lake, 90; Chewaucan, 55; Blitzen, 56.

SOUTH DAKOTA—Water supply outlook for irrigation areas near the Black Hills is fair. Storage is below normal. Soil moisture conditions in irrigated areas are reported as fair to poor.

TEXAS—The water supply outlook for West Texas along the Pecos and Rio Grande is fair to poor. Storage is above normal in Elephant Butte on the Rio Grande and Red Bluff Reservoir on the Pecos, but inflow to these reservoirs from snowmelt will be negligible. Soil moisture conditions in irrigated areas are poor.

UTAH—A fair water supply is in prospect for the area bounded on the north by the tributaries of Bear River in Idaho and Wyoming, and on the south by the Upper

Duchesne River and the streams draining into Utah Lake. Most streams here will yield from about 70 to 95 percent of average flow. South of this area to the Arizona State line and in the Uintah Basin, other than the Upper Duchesne, the outlook is for only fair to critically short water supplies. In this area forecasts vary between 16 and 76 percent, with most forecasts in the 30 to 60 percent range. Reservoir storage in the State generally is above average and will prove to be a vital factor for those having rights to its use.

WASHINGTON—Snowpack in the State of Washington varies from 75 percent to 145 percent of normal. Forecasts of streamflow vary from 75 percent to 121 percent of normal. Snowfall has been very good in the northern part of the State and in the tributary basins of the Okanogan, Similkameen and Pend Oreille Rivers. Snowpacks are below normal in those watersheds which lie south of the Wenatchee River along the east slope of the Cascades and south of the Skykomish River west of the Cascades.

The soil mantle beneath the snowpack is wet, as indicated by soil moisture measurements. Reservoirs used for irrigation and power show above normal storage for this time of year.

Substantial gains have been made in the snowpack during the late winter months. The water supply picture, then only fair, has improved to its present state of good over most of the State.

WYOMING—The water supply outlook for Wyoming irrigated areas is relatively good. Streamflow will generally be near to or only slightly below normal. There is, however, an area of snowpack deficiency on the Popo Agie watershed. The snowpack on a small area of the northern slope of the Bighorn Mountain is at a record high, but the record period is short.

With near normal inflow and carryover storage the water supply along the North Platte is good, although there may be some deficiency on the Laramie and smaller tributaries. Soil moisture in irrigated lands is good.

The flow of the Bighorn River will be below normal. Storage in Boysen Reservoir as well as in smaller irrigation storage reservoirs on the Wind River is very low. Inflow to Buffalo Bill Reservoir on the Shoshone River is expected to be near average but storage is very low.

The flow of the Green River will be generally less than average, but will be adequate to meet local water demands.

WATER STORED IN WESTERN RESERVOIRS

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Mar. 31, 1958	Mar. 31, 1959
Region 1	Baker	Thief Valley	17,400	17,800	17,400
	Bitter Root	Lake Como	34,800	8,300	21,800
	Boise	Anderson Ranch	423,200	165,700	290,700
		Arrowrock	286,600	123,700	275,100
		Cascade	654,100	291,400	407,100
		Deadwood	161,900	50,400	70,500
		Lake Lowell	169,000	152,100	154,300
		Lucky Peak	278,200	194,900	180,800
	Burnt River	Unity	25,200	12,300	19,200
	Columbia Basin	F. D. Roosevelt Lake	5,072,000	2,034,000	2,672,000
		Banks Lake	761,800	751,100	764,500
		Potholes	470,000	231,800	277,800
	Deschutes	Crane Prairie	55,300	55,000	54,000
		Wickiup	187,300	195,000	200,000
	Hungry Horse	Hungry Horse	2,982,000	1,669,100	1,839,600
	Minidoka	American Falls	1,700,000	1,691,600	1,603,100
		Grassy Lake	15,200	12,900	11,900
		Island Park	127,200	127,400	126,900
		Jackson Lake	847,000	490,400	484,900
		Lake Walcott	95,200	80,600	93,400
	Ochoco	Ochoco	47,500	38,300	31,800
	Okanogan	Conconully	13,000	8,300	9,700
		Salmon Lake	10,500	9,700	8,900
	Owyhee	Owyhee	715,000	637,500	523,800
	Palisades	Palisades	1,202,000	758,600	724,000
	Umatilla	Cold Springs	50,000	50,000	50,000
		McKay	73,800	66,100	68,500
	Vale	Agency Valley	60,000	57,200	34,500
		Warm Springs	191,000	180,000	133,800
	Yakima	Bumping Lake	33,700	27,200	8,100
		Clear Creek	5,300	5,300	5,300
		Cle Elum	436,900	170,600	341,800
		Kachess	239,000	139,900	190,700
		Keechelus	157,800	87,200	118,700
		Tieton	198,000	114,600	140,400
Region 2	Cachuma	Cachuma	201,800	107,200	200,200
	Central Valley	Folsom [2]	920,300	[3] 569,900	472,200
		Jenkinson Lake	40,600	41,200	40,800
		Keswick	20,000	18,300	17,200
		Lake Natoma	8,800	1,900	8,500
		Millerton Lake	427,800	386,200	243,100
		Shasta Lake	3,998,000	3,740,200	3,280,000
		Lake Thomas A. Edison	125,100	(1)	61,700
	Klamath	Clear Lake	513,300	414,100	287,400
		Gerber	94,300	86,700	55,100
		Upper Klamath Lake	524,800	471,400	406,300
	Orland	East Park	50,600	49,200	50,900
		Stony Gorge	50,000	45,700	51,200

[1] Not reported.
[2] Corps of Engineers Reservoir.

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Mar. 31, 1958	Mar. 31, 1959
Region 3	Boulder Canyon	Lake Mead	27,207,000	19,092,000	20,735,000
	Parker-Davis	Havasu Lake	216,500	72,200	565,800
		Lake Mohave	1,809,800	1,737,900	1,702,800
	Salt River	Apache Lake	245,100	239,000	242,000
		Bartlett	179,500	145,000	71,000
		Canyon Lake	57,900	54,000	53,000
		Horseshoe	142,800	106,000	43,000
		Roosevelt	1,381,600	264,000	405,000
		Sahuaro Lake	69,800	64,000	48,000
Region 4	Eden	Big Sandy	38,300	(³)	5,100
	Fruitgrowers Dam	Fruitgrowers	4,500	4,500	4,000
	Humboldt	Rye Patch	190,000	100,300	123,200
	Hyrum	Hyrum	15,300	12,200	12,900
	Mancos	Jackson Gulch	9,800	7,800	4,000
	Moon Lake	Midview	5,800	5,400	6,200
		Moon Lake	35,800	(³)	10,500
	Newlands	Lahontan	290,900	234,000	254,000
		Lake Tahoe	732,000	625,200	554,400
	Newton	Newton	5,400	3,800	2,300
	Ogden River	Pineview	110,200	4,700	22,000
	Pine River	Vallecito	126,300	66,200	47,000
	Provo River	Deer Creek	149,700	95,800	86,100
	Scofield	Scofield	65,800	41,500	35,700
	Strawberry Valley	Strawberry Valley	270,000	159,800	157,700
	Truckee Storage	Boca	40,900	9,000	2,100
	Uncompahgre	Taylor Park	106,200	83,100	56,700
	Weber River	Echo	73,900	43,500	38,600
Region 5	W. C. Austin	Altus	162,000	92,200	86,500
	Balmorhea	Lower Parks	6,500	6,200	5,700
	Carlsbad	Alamogordo	122,100	100,000	124,400
		Avalon	6,000	1,600	1,900
		McMillan	32,300	25,600	29,900
	Colorado River	Marshall Ford	1,837,100	840,300	746,500
	Middle Rio Grande	El Vado	194,500	38,200	2,800
	Rio Grande	Caballo	340,900	123,000	185,200
		Elephant Butte	2,185,400	705,000	889,100
	San Luis Valley	Platoro	60,000	30,400	34,000
	Tucumcari	Conchas ²	467,300	153,600	254,800
	Vermejo	Reservoir No. 2	2,900	1,800	2,500
		Reservoir No. 13	5,000	3,200	4,200
		Stubblefield	16,100	8,300	8,900
Region 6	Missouri River	Angostura	92,000	58,100	50,600
		Boysen	710,000	212,600	100,100
		Canyon Ferry	1,615,000	1,169,900	1,346,200
		Dickinson	13,500	6,100	5,800
		Fort Randall ²	4,900,000	2,289,600	2,979,000
		Garrison ²	18,100,000	4,565,900	3,965,900
		Lake Taschida	218,700	72,100	78,300
		Jamestown	39,200	13,000	11,400
		Keyhole	190,300	2,800	4,700
		Lewis and Clark Lake ²	385,000	288,700	306,400
		Pactola	55,000	14,600	19,400
		Shadehill	300,000	80,900	86,000
		Tiber	762,000	87,300	145,500
	Belle Fourche	Belle Fourche	185,200	78,200	58,200
	Fort Peck	Fort Peck ²	14,839,000	3,399,700	5,136,900
	Milk River	Fresno	127,200	63,500	86,800
		Nelson	66,800	47,900	42,500
		Sherburne Lake	66,100	23,700	36,900
	Rapid Valley	Deerfield	15,100	11,600	9,300
	Riverton	Bull Lake	152,000	60,600	45,500
		Pilot Butte	31,600	20,700	12,100
	Shoshone	Buffalo Bill	380,300	130,000	13,600
	Sun River	Gibson	105,000	31,200	61,900
		Pishkun	30,100	12,100	19,400
		Willow Creek	32,400	20,600	28,700
Region 7	Colo.-Big Thompson	Carter Lake	108,900	100,500	81,500
		Granby	465,600	286,300	246,000
		Green Mountain	146,900	70,900	49,100
		Horsetooth	141,800	116,200	95,400
		Shadow Mountain	1,800	1,200	600
		Willow Creek	9,100	3,000	2,000
	Missouri River Basin	Bonny	167,200	43,100	40,900
		Cedar Bluff	363,200	185,400	171,900
		Enders	66,000	36,000	32,100
		Harlan County ²	752,800	274,000	247,200
		Harry Strunk Lake	85,600	33,600	35,800
		Kirwin	304,800	81,500	80,900
		Swanson Lake	249,800	116,300	118,000
		Webster	257,400	54,600	69,500
	Kendrick	Alcova	24,500	27,900	27,100
		Seminoe	957,000	561,400	597,200
	Mirage Flats	Box Butte	30,400	25,700	24,400
	North Platte	Guernsey	39,800	30,000	8,300
		Lake Alice	11,200	1,900	4,400
		Lake Minatare	59,200	31,800	37,600
		Pathfinder	1,010,900	797,000	186,400
Alaska Dist	Eklutna	Eklutna Lake	160,000	94,900	60,400

² Corps of Engineers Reservoir. ³ Includes some superstorage above active capacity.

New Commissioner of Reclamation

Continued from page 38

During World War II, from 1944 to 1946, he served as a lieutenant in the U.S. Naval Reserve. As a military government staff officer on islands of the Pacific reoccupied by Allied forces, he was responsible for the development and administration of agricultural programs.

Mr. Dominy was born in Hastings, Nebr., in 1909 and was educated in the Hastings public schools and Hastings College. He obtained his B.A. degree in agriculture from the University of Wyoming in 1932 and did postgraduate work at the University of Wyoming and Columbia University.

He married Alice Criswell of Adams County, Nebr., December 23, 1929. They have three children and one grandchild: Mrs. Janice Elaine DeBolt and daughter, Jancey Lynn, of Torrington, Wyo.; Charles E. Dominy, a cadet at the U.S. Military Academy at West Point; and Ruth Ellen Dominy, 12, who lives at home with the Dominys at Oakton, Va. ##

SODIUM CHLORATE AND SAFETY

The use of sodium chlorate as a weed control material is not generally recommended because of its dermatitis and fire hazard problems. If used, sodium chlorate and other chlorate weed-killing compounds should be handled with extreme caution. The following precautions should be rigidly observed:

1. Sodium chlorate should not be permitted to come into contact with the skin or the eyes. If it gets on the skin or in the eyes, the chemical must be removed immediately by thoroughly flushing the surfaces with water.

2. Sodium chlorate should be stored in tightly covered metal containers. The containers should never be opened in buildings; or placed in fields where there is any livestock.

3. Should sodium chlorate be spilled on the clothing, such clothing, since it constitutes a dangerous fire hazard when dry, should immediately be removed and thoroughly washed. Rubber boots and gloves should be worn by workmen when spraying with the chemical.

4. A person should not be permitted to walk or ride, or to move equipment of any kind through treated areas, and livestock should be kept out of such areas until after a heavy rain, as even slight friction is likely to ignite the vegetation and cause serious fire damage. Areas near buildings where fires might result in loss of life or property should not be sprayed. Smoking should be prohibited while applying sodium chlorate or while working around sodium chlorate containers, equipment, or treated areas. #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5048	Weber Basin, Utah	Jan. 28	Construction of earthwork, pipelines, and structures for trunklines 1.9, P-3.7, and P-20.5; and East Layton, East Sand Ridge, West Sand Ridge, and Val Verda pumping plants.	Olsen Construction & Engineering Co., Ogden, Utah.	$561,236
DC-5116	Fort Peck, Mont	Jan. 15	Construction of stage 01 additions to Dawson County substation.	Electrical Builders Associated, Valley City, N. Dak.	212,942
DC-5117	Colorado River Storage, Paonia Participating Project, Colorado.	Jan. 7	Construction of Paonia Dam and relocation of State Highway No. 133.	Bud King Construction Co., Missoula, Mont.	3,167,176
DC-5119	Central Valley, Calif	Jan. 12	Construction of earthwork, structures, and bituminous surfacing for relocation of Trinity County Road, Stoney Creek to Ridgeville.	Sierra Construction Co., Inc., Merced, Calif.	815,238
DC-5126	Washita Basin, Okla	Feb. 9	Construction of earthwork, structures, and concrete pipelines for Anadarko aqueduct, Western Farmers Electric Cooperative lateral, and Fort Cobb lateral.	B and M Construction Corp., Oklahoma City, Okla.	1,372,551
DC-5129	Missouri River Basin, Kans.	Mar. 11	Construction of earthwork and structures for Osborne canal, Sta. 335+54.1 to 1069+64.4; and laterals and drains. Schedules 1 and 2.	Bushman Construction Co., St. Joseph, Mo.	1,434,548
DC-5136	Boulder Canyon, Ariz.-Calif.-Nev.	Mar 18	One 115,000-hp vertical-shaft, hydraulic turbine for Unit N-8, Hoover powerplant.	Baldwin-Lima-Hamilton Corp., Eddystone Division, Philadelphia, Pa.	1,422,800
DS-5138	Boulder Canyon, Ariz.-Calif.-Nev.	Mar. 20	One 168-inch butterfly valve for Unit N-8, Hoover power plant.	Todd Shipyards Corp., Seattle Division, Seattle, Wash.	418,006
DC-5140	Columbia Basin, Wash	Mar. 18	Construction of Sand Hollow pumping plant and discharge line, Block 83.	Lewis Hopkins Co., Pasco, Wash.	216,631
DC-5154	Missouri River Basin, Colo.	Mar. 23	Reconductoring 29.34 miles of Flatiron-Greeley 115-kv transmission line.	Crawford Electric Co., North Platte, Nebr.	179,966

Construction and Materials for Which Bids Will Be Requested Through June 1959*

Project	Description of work or material
Boulder Canyon, Ariz.-Nev.	1 100,000-kva, 16,500-volt, 3-phase, 180-rpm, vertical shaft, hydraulic-driven generator for Hoover powerplant, Unit N-8.
Central Valley, Calif.	Constructing the indoor-type Corning canal pumping plant, an intake channel, an outlet structure, a switchyard, and discharge lines. Southeast of Red Bluff.
Do	1 3 phase, 3,750 kva, class OA, 60-kv delta to 2.4/4.16-kv wye power transformer with lightning arresters for Corning canal pumping plant switchyard.
Collbran, Colo	Constructing 58,300 linear feet of the Bonham-Cottonwood pipelines of either precast concrete cylinder pipe (pretensioned) or steel pipe, including gate valves, air valves, and linemeters. Near Collbran.
Do	Constructing about 11.5 miles of 8- to 10-foot bottom width unlined canal and about 0.1 mile of 10-foot bottom width earth-lined canal. Southside canal, near Collbran.
Colorado River Storage, Ariz.	4 40- by 52.5-foot radial gates for Glen Canyon dam. Estimated weight: 1,416,000 pounds.
Do	6 7- by 10.5-foot outlet gates, liners, and anchor bolts for Glen Canyon dam. Estimated weight: 1,343,000 pounds.
Do	4 100,000-pound-capacity double-drum electric hoists for Glen Canyon dam. Estimated weight: 178,800 pounds.
Colorado River Storage, Utah.	1st phase clearing, about 6,400 acres, of the Flaming Gorge reservoir site. About 17 miles east of Linwood.
Columbia Basin, Wash.	Constructing about 13.9 miles of open ditch drains and about 4,250 feet of closed drains. Near Mesa, Othello, Quincy, and Moses Lake.
Klamath, Calif	Constructing an outdoor-type pumping plant with a wood superstructure set on wood piling, 3 25-cfs pump units, and 30-inch steel discharge pipes for each pump terminating in a concrete outlet structure. Tule Lake Division, southwest of Tule Lake.
Middle Rio Grande, N. Mex.	Constructing about 5 miles of the 14-foot bottom San Juan Feeder canal, excavating about 1 mile of 150-foot-wide pilot channel, and installing metal jetty units. Near Belen.
Milk River, Mont.	Rehabilitating the Sherburne Lake dam outlet works by installing new high-pressure slide gates, placing additional concrete in the outlet works intake tower and in wingwalls at downstream portal of the outlet works conduit, and placing riprap at the downstream portal of the outlet works conduit. On Swiftcurrent Creek, southwest of Babb.
MRB, Minn	Granite Falls (Stage 04) substation additions will consist of constructing concrete foundations, furnishing and erecting an extension to the existing steel structure and minor new structures, installing 3 230-kv circuit breakers, 1 15,000-kva reactor and associated switches and other electrical equipment, major items of which will be Government furnished.
MRB, Nebr	Constructing the Merritt dam, an earthfill structure 120 feet high, 3,100 feet long, and containing about 1,500,000 cubic yards of material, appurtenant structures, and an access road. About 25 miles southwest of Valentine.
MRB, S. Dak	Sioux Falls (Stage 05) substation additions will consist of constructing concrete foundations, furnishing and installing steel structures, and installing a 115-kv circuit breaker and associated electrical equipment, major items of which will be Government furnished.
Do	Modifying the Shadehill dam outlet works stilling basin and constructing a 72-inch steel pipe drop structure. On the Grand River about 15 miles south of Lemmon.
MRB, Wyo	Constructing the Gray Reef dam, an earthfill structure 30 feet high and 800 feet long, and a concrete-gated spillway. About 2.5 miles downstream from Alcova dam.
Do	Additions to the Pilot Butte switchyard will consist of grading and fencing a new switchyard area, constructing concrete foundations, furnishing and erecting steel structures, installing a 115-kv transformer, circuit breakers, and associated electrical equipment, major items of which will be Government furnished. North of Riverton.
Do	Additions to the Boysen switchyard will consist of minor modifications to the 115-kv bus structure, constructing concrete foundations for and installing 2 115-kv circuit breakers, and installing 115-kv switches and associated electrical equipment, major items of which will be Government furnished. 13 miles south of Thermopolis.
Okanogan, Wash	Installing 2 54-inch cast-iron slide gates and hoists in Conconully dam outlet works. 14 miles northwest of Omak.
Rogue River Basin, Oreg.	Constructing 9 33- to 51-inch precast concrete pipe (pretensioned) siphons totaling about 2,835 feet long, a reinforced concrete bench flume about 330 feet long, 6 concrete checks, and a check and wasteway on the East lateral, near Ashland.
Do	Constructing about 9 miles of 65-cfs-capacity unlined canal, and about 1.5 miles of 130-cfs-capacity unlined canal, and 3 stream inlet structures. South Fork and Daley Collection canals, east of Medford.
Do	Constructing the Phoenix canal diversion dam, a 150-foot-long concrete structure with uncontrolled crest, earth embankments at each end, a reinforced concrete headworks structure with 12- by 10.5-foot radial gate control, and a reinforced concrete fish screen structure with a 5-foot-diameter by 17-foot-long revolving drum fish screen. Northeast of Talent.
Washoe, Nev.-Calif.	Constructing the Prosser Creek dam, an earthfill structure 139 feet high, 1,850 feet long, and containing about 1,700,000 cubic yards of material, a concrete spillway and outlet works structures, and relocating about 1 mile of county road. On Prosser Creek, northeast of Truckee, Calif.
Weber Basin, Utah.	Constructing the second phase of Willard dam, involving the excavation and placement of 9,500,000 cubic yards of earth material, which will bring the embankment to a maximum height of 20 feet and a length of about 15 miles. At Willard Bay, 11 miles northwest of Ogden.
Do	Constructing about 14,300 linear feet of 12- to 24-inch-diameter precast reinforced concrete pipe for heads of 75 to 125 feet, including pressure reducing valves, gate valves, air valves, blowoffs, linemeters, and turnouts; and earthwork and structures for about 12,400 linear feet of unlined open ditch laterals with bottom widths of 2, 3, and 4 feet. Woods Cross laterals, near Salt Lake City.
Do	Constructing about 9,000 linear feet of 6- to 12-inch pipelines with gate valves, air valves, blowoffs, and linemeters. The pipelines may be constructed of mortar-lined and coated or coal-tar enamel painted steel pipe, precast reinforced concrete pipe, precast concrete cylinder pipe (pretensioned), cast-iron, or cement-asbestos pipe. Ricks Creek laterals, near Salt Lake City.

*Subject to change.

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The Reclamation Era

AUGUST 1959

IN THIS ISSUE:

One Ditch System
Flaming Gorge

Official Publication of the Bureau of Reclamation

The Reclamation Era

AUGUST 1960 **VOLUME 46, NO. 3**

In this issue . . .

J. J. McCARTHY, Editor

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take a good look at

Sprinkler Irrigation

In a recent address before the Sprinkler Irrigation Association Open Conference in Chicago, Assistant Commissioner William I. Palmer of the Bureau of Reclamation stated "We are going to need progress in farming as we have never known it before if we are to keep pace with our needs." The Assistant Commissioner pointed out that within 50 years our population will double while harvestable cropland will be reduced to approximately 1 acre per person and that water as well as land is going to be scarce despite all that is being done to rebuild soil and conserve our water supply.

In the United States where not more than 10 percent of the working population is currently engaged in farming and where the numbers of farms and farmers grow smaller year by year, the need for agricultural automation is as real as the dual necessity for water and soil conservation.

The sprinkler irrigation industry, perhaps more than any other segment of industry producing equipment for agriculture production, offers basic farming tools that by their very use insures water and soil conservation as well as more efficient use of available agriculture man-hours.

Yet, too often those charged with planning the development of idle lands and the conservation of land and water resources overlook or fail to recognize sprinkler irrigation as the conservation tool that comes closest to meeting conservation objectives in bringing potentially fertile, idle land into production and providing water for that land.

With few exceptions, sprinkler irrigation can put the right amount of moisture for a given crop on even rolling terrain and uses only 75 percent as much water as is required by other irrigation methods even on level land. Actually, sprinklers could irrigate, with maximum efficiency, one-third more land than is currently being irrigated by other methods without increasing present water consumption.

by E. HOWARD CLAYPOOLE, Managing Director, Sprinkler Irrigation Association, Los Gatos, Calif.

The sprinkler approach to applying water to reclaimed lands requires only that the land be cleared and suitable for tillage. It eliminates the need for costly leveling or changing the contour of the land to accommodate a gravity flow of water. In short, sprinkler irrigation can be engineered to the requirements of the land rather than altering the land to make it conform to an irrigation method.

In this era of scientific farming, sprinkler irrigation provides a method of applying water that offers results based on the capability of engineered equipment rather than the irrigation skill of itinerant or casual labor. It has long been recognized that surface irrigation is only as efficient as the man who handles the shovel. Even at best, irrigation by hand can only *approach* the efficiency of water utilization, the evenness of application and the increased yields and crop quality that are expected with sprinklers.

Sprinkler irrigation is sometimes defined as "controllable rain with built-in irrigation efficiency." Assuming basic water availability, whether it be from ditches, ponds, lakes, rivers and streams or wells, sprinkler irrigation provides the farmer with his own "private" rain. It is controlled "rain" in every sense of the word—"rain" that can be turned on and off as the farmer wills

These symptoms generally refer to unbalanced plant food sources in the feeding root zone. They may indicate deficiencies of the major elements as well as of trace elements.

It is recognized that trace elements may become deficient in sandy soils or sandy soils containing so-called raw humus much sooner than in loam soils. This is very true when such soils have a high pH value, except perhaps in the case of molybdenum. However, sandy soils which have received applications of farmyard manue tend to maintain a more or less satisfactory content of manganese, copper, and boron.

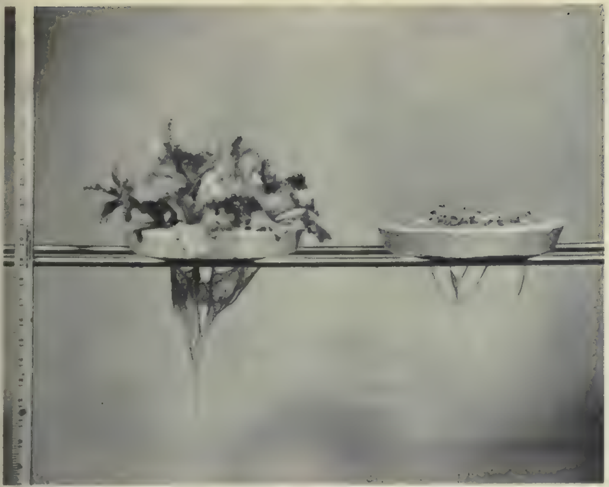
The occurrence of trace element deficiencies varies from one area to another. Many observers report that deficiencies seem to be associated with soils in which one kind of crop is grown continuously, as say in a vineyard or orchard. Furthermore, it is possible to induce a deficiency of several trace elements by an excessive application of lime. This points up the importance of testing the soil in order to determine the quantity of lime needed to adjust the pH to the proper needs of the crop.

Boron deficiency seems more widespread than that of the other trace elements. Borax is the most common carrier applied to soils to correct boron deficiency. Great care is needed to avoid applying an excess of this element to any particular crop since an overdose may prove toxic.

Iron deficient leaf compared to normal leaf, Redlands Mesa, Mesa County, Colo. *Photo by A. F. Hoffman.*

In Florida, for example, celery growers are advised to apply not more than 10 pounds an acre to prevent "crack stem," whereas growers in the Northeast may apply as much as 40 pounds per acre to an alfalfa crop without injurious results.

Magnesium deficiency as shown on Kieffer pear leaves.



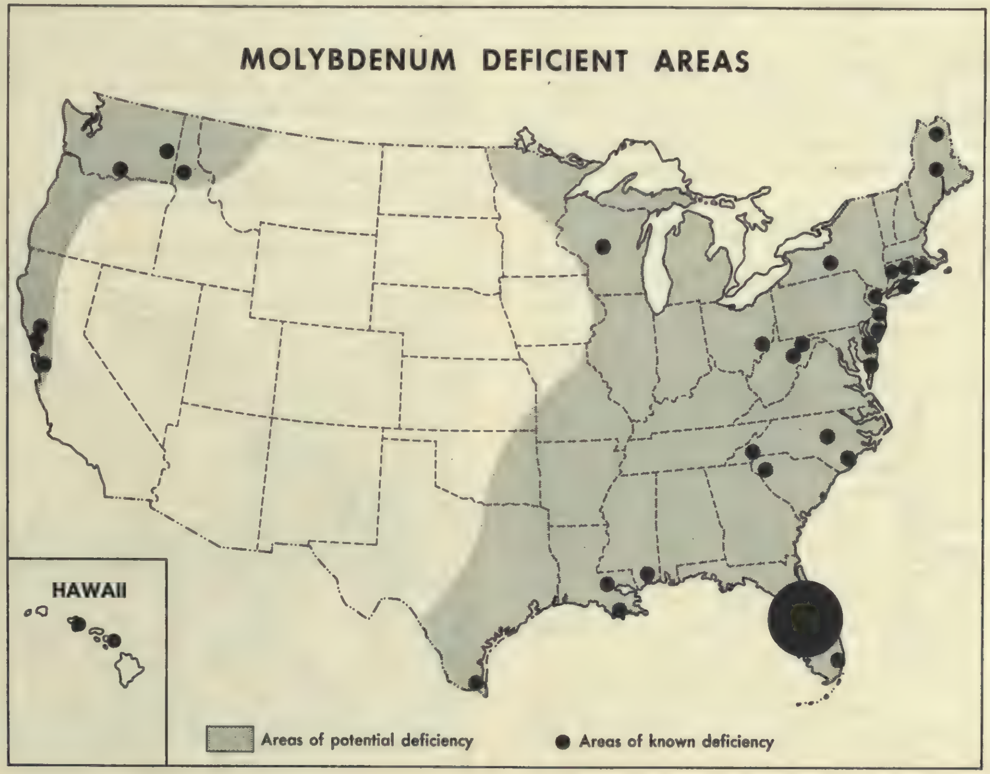
Lettuce grown in nutrient solutions shows effect of molybdenum on growth.

Growers with crops on alkaline marl and muck soils apply 50 pounds per acre of manganese sulfate to maintain the attractive green color in the foliage. Pecan growers apply zinc sulfate to control "pecan rosette," or white-bud of corn. Citrus growers of Florida find it necessary to use magnesium, manganese, copper and zinc according to the symptoms appearing in the foliage.

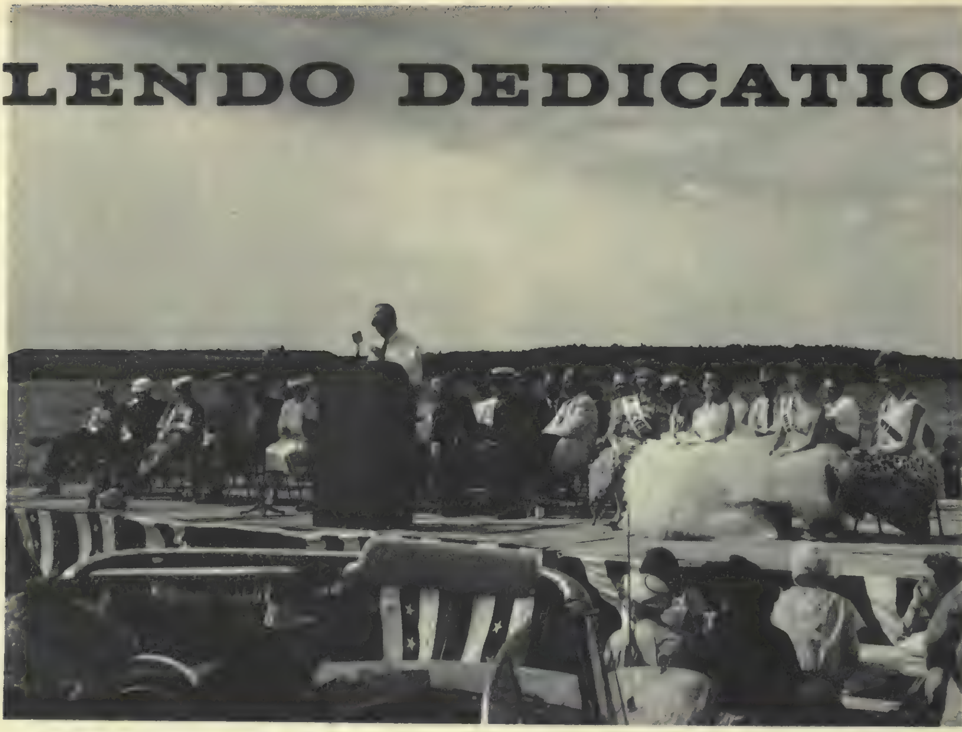
It was slowly but definitely been forced upon farmers in many parts of the country to appreciate that the elements other than nitrogen, phosphorus, and potassium can be of major importance also in growing a crop of normal, vigorous plants. For, no matter how carefully one plans his fertilizer, cover-crop and soil management practices, he cannot afford to neglect to recognize the importance of providing adequate amounts of the trace elements if he wants maximum, profitable yields.

With the recognition that trace elements are vitally important to plants and animals, scientists are beginning to insist that more precise soil tests should be developed for their detection and determination. It is unsatisfactory to wait for foilar "hunger signs" before doing something corrective: yield response to trace elements have been very often obtained in the entire absence of any visual symptoms of deficiency. # # #

Map showing areas of potential deficiency and areas of known deficiency.



GLENDO DEDICATION



SECRETARY FRED A. SEATON

On the plains of Wyoming, more than 6,000 people assembled on June 9 to celebrate completion of Glendo Dam, Reservoir, and Powerplant, newest units in the harnessing of the North Platte River.

The presence of Secretary of the Interior Fred A. Seaton and Commissioner of Reclamation Floyd E. Dominy, a dedication program of entertainment, a buffalo barbeque, and the huge new lake itself combined to attract the remarkably large crowd.

Secretary Seaton, dedicating the facilities, pointed out that the Glendo Unit will make a major contribution to the prosperity of the North Platte Valley, through supplemental irrigation, production of electric energy, and flood control benefits.

Others participating in the ceremony were REA Administrator David A. Hamil, Wyoming Gov. Joe J. Hickey, Iowa Gov. Herschel Loveless, and Maj. Gen. Keith Barney, Division Engineer of the Corps of Engineers of Omaha and Chairman of the Missouri Basin Inter-Agency Committee.

Commissioner Dominy addressed a banquet attended by 200 persons in nearby Douglas the evening of June 9. The banquet both celebrated the Glendo features and was in connection with an MBIAC meeting in Douglas on June 10.

Miss Jeanie Waters of the town of Glendo was "Miss Glendo." Accompanied by beauty queens representing the State of Wyoming and the cities of Casper and Cheyenne, "Miss Glendo" smashed a bottle of champagne against a rock from the dam as the symbol of completion of the dedication.

Glendo Dam is 190 feet high, of earthfill construction and included an ungated concrete spillway. Glendo Reservoir's capacity is nearly 800,000 acre-feet, including 272,800 acre-feet for flood control. On dedication day, the reservoir contained about 525,000 acre-feet, its normal "full" capacity. The big, new body of water, 80 miles southeast of Casper and 110 miles north of Cheyenne, already is being heavily used for recreation.

#

COMMISSIONER FLOYD E. DOMINY

one ditch system

The one-ditch irrigation drainage system was constructed originally for drainage only. Its purpose was to control high water tables in swamp and overflow land bordering the Sacramento River and in the Sacramento-San Joaquin Delta. The system is just what its name implies—one ditch serves both as an irrigation distribution system and as a drainage collection system. Commonly a central drain 7 to 9 feet deep is constructed down the slope of the land and collectors 6 to 7 feet deep are dug at right angles to the main on a flat grade. The size of the ditches is determined by winter flood runoff requirements as flood runoff is larger than summer irrigation demand. In the larger districts main drains usually have 6- to 10-foot bottoms while the collectors have 4-foot bases.

Here is how the system operates:

During the irrigation season water is introduced into the mains at the upper end of the system. In the Sacramento, San Joaquin Delta area, where the river water level is higher than the ground surface, water is siphoned into the system from the adjacent river or delta tidal channels. The irrigation supply within the system is controlled by a series of gates and checks which serve to back the water into the secondary drains or ditches. The controls, installed primarily at road and field crossings, serve to keep the irrigation supply from piling up in the lower end of the system. Normally the summer irrigation supply occupies the bottom 3 to 4 feet of the combined use ditches. The individual farmer then lifts the water from the ditch onto his land through portable pumps similar to those shown in the accompanying photograph. Water is applied through either sprinkler systems or conventional gravity methods.

by J. A. McKEAG
Drainage Specialist, Region 2
Bureau of Reclamation
Sacramento, Calif.

From the foregoing it is obvious that the one-ditch system is most advantageous in areas where a drainage system is required. Lands having 2 to 10 feet fall to the mile lying predominantly in one plane such as valley troughs and lake bed areas describe the conditions best suited to a one-ditch system.

The advantages of a one-ditch system are best

demonstrated by comparison with a conventional irrigation and drainage system under similar conditions. The first obvious advantage is the elimination of dual rights-of-way with the resulting saving of farm land. A second advantage is savings in cost of construction. The few controls required in the one-ditch system plus savings in rights-of-way and added construction costs, compared to a separate conventional gravity irrigation system, would result in savings of $75 to $100 an acre. In addition, an annual saving of $2 to $3 an acre in the operation and maintenance costs would be realized. These savings more than offset the added costs of pumping required to lift the water from the ditches onto the adjacent land. Costs of pumping vary from 5 to 10 cents per acre-foot per foot of lift depending upon whether water is pumped with a permanent electric-driven pump installation or by a portable gas-driven pump. In the Sacramento, Sacramento-San Joaquin area the water requirements average 2½ to 3½ acre-feet per acre, and the net lift is about 5 feet. In other words to lift 3 acre-feet of water 5 feet at 5 cents per acre-foot would cost 75 cents an acre.

Other advantages are: reduced maintenance in the drain system as the depth of water during the summer season restricts weed growth in the drain to the edges; because of reliance on drains for irrigation supply both the districts and the individual farmer keep the drains in good repair; with a portable pump "turnout," diversions can be made from anyplace along the drain eliminating need for head ditches and adding flexibility to field layout.

In actual practice, the shallow drains probably give as good a net control of water level as a conventional dual system having unlined irrigation ditches. In this system there are no water surfaces above ground surface to create hydrostatic pressures. Canal and distribution system losses are eliminated and irrigation flows return immediately to the drains rather than ponding at the ends of the fields. In addition, because irrigation water is diverted by pumping from the drain ditch supply, and pumping is a direct cost to the farmer, he has an added incentive not to over-irrigate or to let the water run.

It might be argued that the shallow depth of effective drainage during the summer months would make such a system ineffective in controlling salinity. It is true that surface and subsurface flows return immediately to the irrigation supply and might be expected to deteriorate the quality of water and, hence, salt up the land especially at the lower portion of the system. The answer lies in what has happened where the system has been in use. After some 30 years of one-ditch irrigation and drainage on 750,000 acres in the Sacramento-San Joaquin Delta no damaging saline condition has been reported at any time or place, nor is there evidence of salt damage to any

Continued on page 79

Robert and Chuck Brown checking the operation of their pumping unit. The unit is pumping more than 1,000 gallons per minute. Water delivery is from the Bartley Canal, Missouri River Basin project, Nebraska. *Photo by L. C. Axthelm.*

RECREATION AND THE COLORADO RIVER STORAGE PROJECT

Today, more than ever before, the out-of-doors is providing the recreation opportunities people of this country are seeking for their increasing leisure time. In the past 10 years visits to national parks have almost doubled and visits to State parks have slightly more than doubled.

One of the major attractions is water—a lake for boating, fishing or swimming, or to provide a scenic setting for a picnic or a campsite. More and more, recreationists are looking for water where they may launch their boats. It is estimated that more than 7 million Americans now own recreational boats, about 3 times as many as 10 years ago. Rivers, the seacoasts, and natural lakes help to meet the demand for places to use boats, but in many parts of the country these resources are being supplemented, to an increasing extent, by manmade lakes.

Studies conducted for the National Park Service in various sections of the country have added to our knowledge of preferences affecting the demand for water-connected recreation. In the Southwest, picnicking, swimming and fishing were found to be the three most popular forms of outdoor recreation. In the Northeast, these forms of recreation were included in the four most popular activities. In studies made in river basins in the Plains States and in the Middle Atlantic region, these activities were also found to be among the five top-ranking activities.

Each of the surveys contained questions designed to measure the extent of unmet recreation demand. Two of the studies provided an opportunity for the individuals reporting to indicate the number of persons not taking part in various activities who would do so if the activity were readily avaliable. In both of these studies, boating was found to be the top-ranking activity in terms of the number of additional persons who would like to participate. Fishing was in second place, while other top-ranking activities were picnicking, swimming, hunting, and ice skating. These answers, and the answers to similar questions in the other surveys, show a consistent pattern of high popularity for recreational activities that require water areas.

Recognizing the popularity of water recreation and the public demand to use reservoirs for recreation, Congress authorized recreation as one of the beneficial uses of the Colorado River Storage Project. Here is an opportunity not only to enjoy water-connected recreation but to do so in a region of top recreational appeal.

The scenic and scientific values of the Upper Colorado Basin have been known since the days of the early explorers. In 1941 the National Park Service undertook an extensive study of the recreation resources of the entire river basin. The report of the survey states: "The Colorado River Basin is one of the outstanding recreational regions in the United States because of its great variety of natural scenery, climatic conditions, areas and objects of scientific interest, and abundant evidence of prehistoric occupation. * * * Here one may enjoy a large amount of sunshine and find perfect climates and settings for various

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types of outdoor recreation the year around * * *. The majority of the proposed reservoirs * * * will create new recreational resources benefiting the basin."

The Colorado River Storage Project Act provides the broadest authority relating to recreation at reservoirs ever authorized by Congress to best promote recreational development and operation to serve the public interest. Section 8 of the act states:

"In connection with the development of the Colorado River Storage Project by the Bureau of Reclamation, including participating projects, the Secretary is authorized and directed to investigate, plan, construct, operate, and maintain (1) public recreational facilities on lands withdrawn or acquired for the development of said project or of said participating projects, to conserve the scenery, the natural, historic, and archeologic objects, and the wildlife on said lands, and to provide for public use and enjoyment of the same and of the water areas created by these projects by such means as are consistent with the primary purposes of said projects * * *."

Following enactment of this legislation, the National Park Service began studies and plans for recreational developments and facilities at those reservoir sites where construction of the dams, by the Bureau of Reclamation, was under way or scheduled at an early date. For a number of the areas, only preliminary general development plans have been prepared, because of limited access to much of the area surrounding the larger reservoir basins.

Aerial view looking almost due north to the site where Stanaker Dam will be constructed. ***Photo by Stan Rasmussen.***

General view of Damsite, Glen Canyon Unit, Colorado River Storage project. ***Photo by J. L. Digby.***

A preliminary general development plan has been completed for the Glen Canyon reservoir area. This reservoir will lie in the heart of the canyon lands of southern Utah and northern Arizona. This area is one of the most rugged, roadless, and inaccessible regions within the continental limits of the United States. Lands on either side of the river canyons present a profusion of greatly eroded winding gorges, ridges and hills. In the background, sheer cliffs and mesa-topped buttes, broken by an occasional mountainous uplift, complete a landscape of vivid color and awesome space. With the reservoir, relatively easy water access will be available to this outstanding canyon country.

The plan for recreation use of the reservoir area shows three major developments. The major sites, when fully developed, will provide facilities for activities directly associated with water and for camping and picnicking, as well as meals, lodging and other services to the public.

First to be developed is the Wahweap site, an area a few miles northeast of the dam, in Arizona and adjacent to a new major highway. Adequate

The completed Wanship Dam shortly before its dedication on May 9, 1957. ***Photo by Stan Rasmussen.***

topographic data has made it possible to prepare a master plan for the area. The plan has been approved, and construction is under way and will continue as rapidly as funds become available.

Other major development areas are proposed in the vicinity of Warm Creek and the Colorado River and where Bull Frog Creek enters the river.

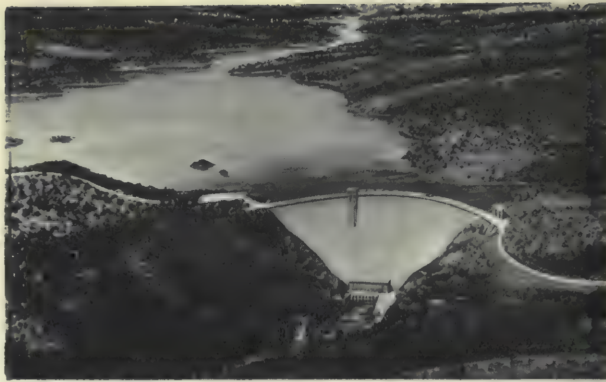
Minor development sites have been chosen at Hole-in-the-Rock and Shock Bar. These sites will serve the boat traveler and fishermen and offer limited accommodations and services.

The Bureau of Reclamation has provided vista houses and parking areas on each side of the river below the dam and has provided uniformed guides who can give information to visitors interested in the construction of the dam.

It is expected that the Glen Canyon reservoir area will be administered by the National Park Service as a National Recreation Area, similar to the Lake Mead National Recreation Area. As a start toward that administration, Mr. James M. Eden was assigned, in May 1959, as project manager of the recreation area, with headquarters at the Wahweap site and residence in Page, Ariz. As funds became available, additional personnel will be assigned for administration, protection, and interpretation.

The Service estimated an expenditure of $10 million as the cost of Federal recreation development at the Glen Canyon area. Concessioners will, no doubt, spend at least $5 million on capital investments. It is expected that the recreational use of the Glen Canyon area will be well over a million visitor-days annually.

An outstanding point of interest for the recreationists who will be attracted to the reservoir is Rainbow Bridge. This unique natural feature, protected for future generations by establishment of Rainbow Bridge National Monument in 1910, is greater than any other known natural bridge in size, color, and in its almost perfect symmetry. The arch of salmon pink sandstone, curving in



Left, artist's conception of Navajo Dam on the San Juan River, east of Farmington, N. Mex. Right, artist's conception of the Flaming Gorge Dam to be constructed on the Green River in Eastern Utah. *Art work by Harold Gill.*

the form of a rainbow, rises 309 feet above the bottom of the gorge.

Concern over the possibility that the Glen Canyon Reservoir might actually damage the natural bridge has been based on such factors as the effect of a permanent body of water at the base of the abutments of the bridge, or of wave action against the abutments, the change in the water table, and the composition and porosity of the rock. Authority to take action to avoid the danger of gradual disintegration of the rock foundation of the bridge is contained in the Colorado River Storage Project Act. The act provides that as a part of the Glen Canyon Unit the Secretary of the Interior shall take adequate protective measures to preclude impairment of the monument. Under the Secretary's direction, the Bureau of Reclamation and the National Park Service have made joint studies to determine the best means of providing adequate protection.

Among the other areas where general development planning has been undertaken are the Flaming Gorge and Navajo units of the Storage Project.

Flaming Gorge Reservoir will provide a large body of water in a semiarid region enhanced by outstanding scenic surroundings. Located near the Continental Divide, with its north-south belt of national parks, national forests and resorts, the reservoir will be located in a vacation area

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Flaming Gorge Reservoir area. Looking downstream on the Green River.

safety is everybody's business *Everyday in the year*

by FORREST E. BYRNS, Commissioner's Office,
Washington, D.C.

All illustrations courtesy of the National Safety Council

Each year, it is customary for the President of the United States to issue a proclamation designating the last full week in July as "National Farm Safety Week." In accordance with that custom, President Eisenhower this year so designated the week beginning July 19, 1959.

By the time this issue of the Reclamation Era is distributed to its readers, that week will be past. The principal objective of such designation, however, is to remind all of our farm residents throughout the country that farm safety is a problem that concerns all of us, and not only for 1 week of the year, but every day of every week of every year.

The health, safety, and prosperity of our rural families are vital to the strength of this Nation. Accidents suffered by the rural inhabitants of this country result in thousands of injuries, many deaths, and considerable property loss each year, and constitute a serious problem.

The number of these accidents can be reduced—if we will all join in a continuing campaign, every day in the year, to prevent needless accidents on the farms, in the fields, and on the farm-to-market highways.

There are two basic kinds of accidents. First, those resulting from mechanical causes such as unguarded machinery; worn or otherwise defective rope, tools, and other equipment; holes in platforms and flooring, etc.; and secondly, those resulting from personal causes such as fatigue, ignorance, carelessness, thoughtlessness, recklessness, insubordination, "horseplay," and other such human failings.

All these causes of accidents can be brought under control by the intelligent and conscientious farmer who recognizes it as his duty to study the hazards on his farm, whether they be mechanical or personal, and to take appropriate steps to eliminate or make them harmless.

Past accidents can be valuable guides in preventing similar ones in the future. Above all, the farmer or farm worker must not allow himself to fall into the mistaken attitude that accidents always happen to "the other fellow" and never to himself. He may be that other fellow next time. Vigilance is the necessary price of farm safety.

Unlike the factory worker, the farm worker lives at his place of work and so he is exposed to the hazards of his occupation for longer periods. Safety rules and regulations enforced by systems of inspection and fines for violation help to protect the factory worker. On farms the rules of safety must necessarily be enforced by the farmer himself.

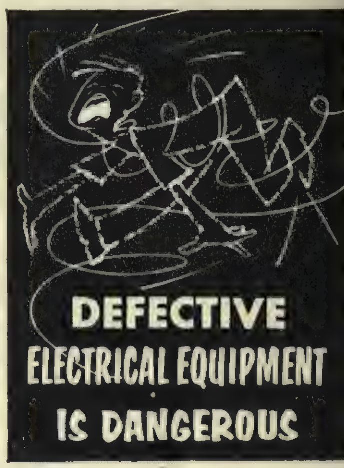
Each farm is a unit in itself and as such is responsible for its own safety. It is the farmer and his helpers who must keep the farm a safe place on which to work and live.

It is probably the every day negligences that cause most farm accidents. They may not be spectacular, but they disable workers, add to labor problems, increase insurance costs, and reduce farm income. Farm safety depends on continuing

vigilance, with constant checking, repairing, and maintenance of equipment in good order. A few minutes spent in removing an obvious hazard will save many a hard-earned dollar. The following check lists of common farm hazards may be of assistance in helping our readers to eliminate accidents on the farm. Every farm operator is urged to give thoughtful consideration to each item to determine if there are any suggestions or reminders here which might improve his own operations.

Autos, Trucks, and Tractors

1. Keep trucks and autos in good mechanical condition. Brakes, steering mechanism, tires, and lights should be checked frequently.
2. Make sure your drivers are licensed, and see that they obey State vehicle laws.
3. Warn workmen about the hazards of riding in open and flat bed trucks.
4. Before transporting employees in trucks, enclose the truck bed on all sides and provide fixed seats.
5. Lash a load securely to the truck.
6. Don't overload a truck.
7. Don't allow workmen to ride on top of loads.
8. Don't allow workmen to ride with their legs hanging outside the truck.
9. Before starting a tractor motor, see that it is out of gear and that the brake is set.
10. Don't operate a tractor on dangerous inclines or too near steep banks or irrigation ditches.
11. Don't drive a tractor at over four and one-half miles per hour during off-the-road operation.
12. Do all pulling from the tractor draw bar. Don't hitch anything to the axle.
13. If someone is helping to hitch an implement to the tractor, be careful not to back into him with the tractor.



Machinery

1. Guard V-belts, pulleys, chains, sprockets, power takeoffs, and gears on your farm machinery against accidental contact.
2. Guards removed for repair or other purposes should be put back as soon as possible.
3. Never clean machines with gasoline or liquified petroleum gas. Use a high flash point solvent.
4. Turn off the power before adjusting or cleaning machinery.
5. Keep children away from machinery.
6. Don't step over or under moving belts.
7. Don't wear loose or torn clothing or torn or ragged gloves near moving machinery.
8. Don't climb over or around a combine or thresher that is operating.
9. Don't get in front of a mowing machine to make adjustments while it is in gear.
10. Make sure that your workers know the proper way to use farm equipment for the job they do.
11. Never operate a spray tower or other ele-

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FLAMING GORGE

The Flaming Gorge Unit is one of the four storage reservoirs authorized for construction on the Colorado River Storage Project. The principal features of the unit are the Flaming Gorge Dam, powerplant, and switchyard. The dam is located on the Green River about 6 air miles south of the Utah-Wyoming State line in Daggett County, Utah. The dam, community of Dutch John and about 27 miles of the reservoir are located inside the Ashley National Forest.

Daggett County is located in the extreme northeastern corner of the State of Utah and prior to the start of construction of Flaming Gorge Dam its population was about 350 people. The county is bisected by the Green River which flows through deep colorful canyons. Prior to construction of a bridge across the river by the Bureau of Reclamation the inhabitants of the eastern part of the county were obliged to travel some 100 to 120 miles through Rock Springs and Green River, Wyo., to reach Manila, Utah, the county seat of Daggett County. Daggett County contains some of the most beautiful and the most rugged terrain in the State of Utah and abounds in excellent fishing streams and big game hunting areas.

The dam is to be a thin arch-type concrete structure having a structural height of about 495 feet above its foundation with a crest length of 1,180 feet and containing about 922,000 cubic yards of concrete. The powerplant, located at the downstream toe of the dam, will have 3 generating units, each of 36,000 kilowatt capacity. A 2-lane roadway will cross the crest of the dam and eventually will become a link in the primary highway connecting U.S. 30, near Green River and Rock Springs, Wyo., and U.S. 40 at Vernal, Utah. The

by JEAN R. WALTON, Construction Engineer, Flaming Gorge Unit, Dutch John, Utah

reservoir will have a storage capacity of 3,930,000 acre-feet and will extend upstream some 91 miles to within 4 or 5 miles of Green River, Wyo. The area draining into the reservoir will cover 15,000 square miles in Wyoming and Utah. The normal maximum water surface of the reservoir will be at elevation 6,040 with the crest of the dam at elevation 6,047.

Actual work on the Flaming Gorge Unit was initiated when the Bureau of Reclamation established a temporary project office in Vernal, Utah, in August of 1956. Most of the field engineering crews were required to live in trailers at Manila, Utah, or to commute from Green River, Wyo. This arrangement was necessary until sufficient facilities and housing were constructed at the damsite to permit moving the project headquarters and personnel near to the site of the work.

The first actual construction was started following the award of a contract to the Wangsgaard Construction Co. of Logan, Utah, in January 1957, for construction of the first 7½ miles of access road and a temporary timber pile bridge across the Green River. With completion of a second access road construction contract in June 1958, a road connection was made between Dutch John, on the east side of the river and Manila, Utah, and

Above, Flaming Gorge Unit. Dutch John, Utah, Utah's newest town. Right, looking downstream on the Green River. *Photo by F. B. Slote.*

Green River, Wyo., on the west side of the river.

The area that was selected for the community site was probably one of the most isolated and inaccessible locations in the State of Utah. It was visited very infrequently by a few sheep and cattle men and by numerous hunters during the big game season. The area around the community of Dutch John abounds with deer during the latter part of the hunting season as it has throughout the past been a migratory feeding ground during the

Government campsite at Manila, Utah. Log cabin in foreground is the Bureau's first field office in the Manila area.

winter months for deer from the higher country.

The only semblance of civilization in the Dutch John area was the Pacific Northwest high pressure gas pipeline and a dirt airstrip.

A contract was awarded to the Witt Construction Co. of Provo, Utah, in July 1957, for the construction of the community facilities at Dutch John. The amount of this contract was slightly under two and three quarter million dollars. The contract covered the general grading for the community, construction of streets and sidewalks, construction of a sewer collecting system, a sewage treatment plant and ponding areas, a water distribution system, a power distribution system and the construction of 80 O and M type residences. In January 1958, when it appeared that the prime contract for the construction of the dam and powerplant would be delayed 1 or 2 years, this contract was modified to delete 30 of the 80 residences.

Work was started on the contract in August 1957 and was substantially complete in February 1959.

Other construction required at Dutch John for establishment of the community, consisted of erection of Transa-houses and trailers, construction of two temporary warehouses, construction of temporary metal garages, and construction of a laboratory, administration building, and garage and fire station. These facilities have all been completed and the community is now taking on a finished appearance.

The Daggett County school district with the help of Federal funds, awarded a contract in September 1957 for the construction of a four classroom school building at Dutch John which was completed and ready for classes by September 1958. The grade school at Dutch John accommodates the first six grades and a kindergarten. Children in the seventh and eighth grades and in high school are transported by bus some 20 miles to Manila, Utah.

The first Bureau of Reclamation people were moved into Dutch John in January 1958, and by May 1958, sufficient Transa-homes and trailers and utilties were available to accommodate most of the organization.

Bids for the construction of Flaming Gorge Dam and powerplant ranged from a low of $29½ million to a high of over $50 million. The low and successful bidder was the Arch Dam Constructors of Omaha, Nebr. This company is a joint venture consisting of Peter Kiewit Sons' Co., Omaha, Nebr.; Morrison-Knudsen Co., Boise, Idaho; Midvalley Utility Constructors, Houston, Tex.; and Coker Construction Co. of Omaha, Nebr. Peter Kiewit Sons' Co. is the sponsor and is running the job for the joint venture.

The prime contract was awarded on June 18, 1958, and notice to proceed was issued on July 1, 1958. Since the latter date, the contractor has completed most of its camp construction and most of the construction in its shop and warehouse areas.

The contractor has worked throughout the winter on the construction of the access road from Dutch John to the left abutment of the dam and on the powerplant service road to river level in order to gain access to the damsite for heavy construction equipment. All of this road work has been very heavy construction consisting in the main part of exceptionally deep rock cuts. The construction of these roads is now nearing completion.

The Coker Construction Co., one of the joint venture, excavated the diversion tunnel in the right abutment of the dam. The diversion tunnel

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Administration building, Bureau of Reclamation, Dutch John, Utah.

N. B. BENNETT, Jr.

WILLIAM I. PALMER

KEY PERSONNEL CHANGES

Selection of two new assistant commissioners of the Bureau of Reclamation was announced recently by Secretary of the Interior Fred A. Seaton. They are both from the ranks of the Bureau career service.

They are: N. B. Bennett, Jr., who will be Assistant Commissioner for Engineering and Power, and W. I. Palmer, who will be Assistant Commissioner for Project Development and Irrigation.

The new appointments were made on the recommendation of Commissioner Floyd E. Dominy, head of the Bureau of Reclamation.

The new Assistant Commissioners in addition to the Assistant Commissioner for Administration, A. R. Golze, and the Assistant Commissioner and Chief Engineer, Grant Bloodgood, who headquarters at the Reclamation Engineering Center in Denver, Colo., complete the Bureau's top command.

Mr. Bennett was chief of the Division of Project Development, a position he held since 1953. A native of Sheridan, Wyo., he received a B.S. in civil engineering from the University of Nebraska He first worked for the Bureau of Reclamation in 1933 on construction of Kendrick project in Wyoming. After some private employment and 3 years as assistant State engineer and engineer-secretary for the Wyoming Water Conservation Board, he returned to the Bureau of Reclamation in 1942 as assistant engineer at the Salem, Oreg., field office.

A year later he transferred to the office of the Chief Hydraulic Engineer at Denver. In July 1945 he transferred to Washington, D.C., as Assistant Chief of the newly created Division of Engineering Surveys in the Branch of Project Planning. He became Assistant Director of the Branch in 1946 and Director in 1953.

Mr. Bennett also serves as Chairman of the U.S. section of the International Engineering Board with Canada on water problems of the Souris-Red and the Wateron-Belly Rivers.

Mr. Palmer, who was Chief of the Irrigation Division, is a native of Cedar City, Utah, and received a B.S. degree in agricultural economics at Utah State Agricultural College, Logan, Utah. After a period of private employment he entered the Federal service in 1935 as manager of the Widtsoe land-use adjustment project of the Department of Agriculture in southern Utah.

He served in various other capacities in the Department of Agriculture, particularly in the

Resettlement Administration and Soil Conservation Service, before transferring to the Bureau of Reclamation in 1944. He has worked in Bureau of Reclamation Regional offices in Salt Lake City, Utah, and Sacramento, Calif., as well as in Washington, D.C.

Prior to being named Assistant Chief of the Irrigation Division in 1956, Mr. Palmer was Chief of the Contracts and Economics Branch where he administered a billion dollar repayment program. He was named Chief of the Irrigation Division in January 1958.

LEON W. HILL

Another key personnel appointment was announced by Interior Secretary Fred A. Seaton. This was the promotion of Regional Irrigation Supervisor LEON W. HILL to the position of Regional Director at the Bureau's Region 5 Office in Amarillo, Tex. This appointment was also made upon Commissioner Dominy's recommendation.

Mr. Hill was born in Winters, Tex., and holds a BA from New Mexico A & M and a masters degree from the University of Texas. He first taught at Las Cruces Union high school, New Mexico, and, in 1936, began his Federal career with the Department of Agriculture.

He remained with the Department of Agriculture until the war when he served with the Army Corps of Engineers in the Pacific. He was discharged as a lieutenant colonel in March 1946.

He then worked briefly with the Department of Agriculture in Washington until appointment as an agricultural economist in the Irrigation Division of the Amarillo office of the Bureau of Reclamation in July 1946. He was named chief of the allocations and repayment branch in 1948, assistant regional irrigation supervisor in 1950 and regional supervisor in 1952. As Regional Director, he will have general supervisory responsibility for Bureau of Reclamation affairs in Texas, Oklahoma, New Mexico and the Rio Grande basin area in southern Colorado. #

"GET ACQUAINTED" COPIES

If you have friends or associates who would be interested in the RECLAMATION ERA, please send their names and addresses to the Bureau of Reclamation, Washington 25, D.C. We shall be glad to send them copies of back issues.

Sound-Slide Film on Molybdenum in Agriculture Produced by Climax

The story of the trace element molybdenum—an essential nutrient in the growth and development of crops—is portrayed in a new sound-slide film produced by Climax Molybdenum Co. and available for presentation before agricultural and farm groups.

Presented in a combination of photographs and lively cartoon art, the film points out how molybdenum can spell the difference between crops of high yield and quality and those of low or average harvest and health. The film highlights an important new method of application whereby seed is treated before planting. Also featured is a newly developed form of molybdenum, known as Moly-Grow.

Called "Moly-Gro Means Money," the film is in color, runs some 15 minutes in length, and can be used on either automatic or manually operated sound-slide film projectors. It can be obtained on loan from: Climax Molybdenum Co.; Division of American Metal Climax, Inc., 500 Fifth Avenue, New York 36, N.Y. #

Safety Is Everybody's Business

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vated equipment within 6 feet of high voltage lines.

Hand Tools

1. See that portable electric hand tools have a 3-pronged plug for automatic grounding.
2. Replace broken or splintered handles on axes, sledges, hammers, picks, and other hand tools. Handles should fit tight and should be free from splinters.
3. Dress and round off mushroomed heads of "shock" tools, such as wedges, chisels, and sledge hammers.
4. Keep edged tools such as knives, axes, and chisels sharp and at the proper cutting angle.
5. Provide storage space for hand tools in a proper place, such as a tool house, bin, rack, or box. Keep them there when not in use (leaving hand tools scattered around may cause injury).
6. See that workers know how to use hand tools correctly.
7. Use the proper tool for the job.

Ladders

1. Always inspect a ladder before using it.
2. Store your ladders, under cover, horizontally, with sufficient supports to prevent sagging.
3. Check all ladders and repair them before harvesting or pruning begins.
4. Don't paint ladders, for paint hides defects. Use oil or clear varnish.
5. Never stand higher than the second rung from the top.
6. Don't overreach when on a ladder.
7. Don't carry heavy or unwieldy loads on a ladder.
8. If a portable straight ladder is used on a smooth surface, prevent slipping by nailing cleats against the feet of the ladder or use safety shoes on the ladder.
9. If possible, use stepladders less than 10 feet high. Never use stepladders more than 20 feet high.
10. Use orchard or single pole ladders on soft ground only.
11. Use the right ladder for the job. Don't use makeshift ladders.
12. Don't leave ladders where children may climb them or run into them.

13. Don't place a metal ladder where it can come within 6 feet of a high voltage line.
14. Face the ladder when climbing or descending it.

Work Areas

1. Keep floors, ramps, and runways clear of slippery material.
2. Place standard handrails around ladder openings and stairways.
3. Place standard guard rails on all platforms and working surfaces that are more than 4 feet above the ground.
4. Keep walks and passageways clearly lighted and free from obstructions.
5. Repair broken flooring.
6. Place a standard guard around open holes in the floor.

7. Provide trapdoors over floor openings and keep the trapdoors closed. When it is necessary to have trapdoors open, keep floor openings guarded.

8. Keep floors and working areas free of debris and other obstructions.

9. Secure men against slipping or falling before they begin to repair roofs or clean gutters.

10. Don't store loose materials above shoulder height.

11. Remove nails from loose boards without delay.

12. Keep farmyards clear of garden tools, forks, rubbish, and waste.

13. Make sure that staging and scaffolds are well constructed, well braced, and well guarded.

Animals

1. Approach an animal from the side or front, and speak to it as you approach.

2. Keep children away from pens and barns.

3. Use a staff when handling bulls.

4. Keep a bull in a strong pen having emergency exits.

5. Don't clean a bull pen while a bull is in it.

6. Use special care in handling animals with newborn young.

7. Don't antagonize or teas animals.

In the Home

1. Keep stairways free from any obstructions.

2. Keep stairways and hallways properly lighted.

3. Provide a strong handrail on all stairways.

4. To reach things above you, use a ladder. Don't use chairs or makeshift devices.

5. Don't let the electrical parts of an appliance become wet.

6. Don't use a lamp cord to supply current for equipment or appliances.

7. Never turn on a light, or touch electrical equipment, while you are in a bathtub.

8. If you are standing on a wet floor, don't plug in electrical equipment.

9. Don't touch any grounded metal, such as radiators or water faucets, while handling an electrical appliance.

10. Don't run extension cords through door openings or under rugs.

11. From time to time, inspect electrical toys and other appliances for defective or worn cords.

12. If you think that an electrical appliance may be faulty, check it at once, and repair it if necessary.

13. Store matches, poisonous materials, acids, and flammable substances out of reach of children.

14. Be sure that poisons are clearly labeled.

15. Don't allow paper, rags, or other combustible rubbish to accumulate in attics, basements, or closets.

16. Don't use gasoline or kerosene to start a fire.

17. Don't use gasoline or naphtha as a cleaning solvent.

18. For ashes, use only metal containers.

19. Don't use coins to repair burned out fuses.

20. Provide a metal or asbestos stand for your iron.

21. Don't let handles of cooking utensils extend beyond the stove.

22. Make sure that all firearms are unloaded. Keep ammunition locked up.

23. Keep stair carpeting securely fastened, and all small rugs anchored.

24. Don't light a gas stove or furnace if you think gas is escaping.

25. Be sure you know the location of gas, water, and electricity shutoffs, in case of emergency.

26. Be sure that firefighting apparatus is in good condition and ready for use.

The true wealth of our Nation lies not only in its natural resources, but in its human resources. The safeguarding of these priceless human resources, therefore, is the soundest possible investment for the farmer, for his family, and for his community. # # #

a new western HERO

There is a new law man at work in the irrigated West. Like many famous enforcers of law and order in the old West, he is known by a variety of names. To Dr. René Blondeau (technologist for the Shell Development Co. which has been conducting experiments with the new product) he is known as F–98. He is a member of the growing family of herbicides. His chemical identity is C3 H4 O, and his real name is Acrolein. A potential protector of the public's interest in canals and laterals, he can make it tough on public enemies of the irrigation world—namely, pond weeds.

Last summer, this public hero made short work of such desperadoes as Sago, Giant Sago, Richardson, and other pond weeds, and all the algae. His activities, so far on an experimental basis, ranged from Arizona to Washington, and from Idaho to Florida. He worked in irrigation canals, large and small, drain ditches, and ponds.

Sometimes he was strong; sometimes he was weak; but always astoundingly effective for almost unbelievable distances. Not only did he kill his victims, but he caused them to disappear. The weeds became flaccid almost immediately, gradually disintegrated, and floated away. In a week or 10 days, they simply could not be found in the channels they formerly choked.

This public protector's method of operation is simply to break down plant cells by reacting with various of their vital enzyme systems. This destroys all plant tissue above ground. Since the tissues slough off gradually, there is no clogging of canal structures by debris. Contrast this to the old mechanical method of ditch digging with chains which merely breaks aquatic weeds loose and often requires removal by hand or machine of loose weeds as they pile up farther downstream.

One of the irrigation canals in which this new herbicide operated in Idaho last summer was the Notus Canal in the Boise Valley. This canal has an infamous reputation for its ability to grow pond weeds. Its water supply comes primarily from drains and therefore, has all the help it needs for continuing infestation. It is a small canal having a capacity of 150 second feet at its heading, and decreasing until at Mile 28, it runs only about 5 cubic feet per second. Laterals leading from the canal start at Mile 10 and come in at intervals downstream.

Experimental wholesale raids on the pond weeds in this system started on the night of July 7, 1958, at 10 p.m., when the writer began pumping F–98 into the head of the Notus Canal. The material was applied in a reduced canal flow of 100 second feet at the rate of 250 gallons over a period of 1 hour.

Passage of this water-loving hero through the body of the canal dealt speedy death to the pond weeds. Not even densely matted weeds growing

by JOHN WALKER, Manager, Black Canyon Irrigation District, Notus, Idaho


Left, application of experimental herbicide, F98, for pond-weed control, Notus Canal, Black Canyon irrigation district, Notus, Idaho. Right, cutting and removal of pond-weeds by hand.

along the waterline could escape, for this killer penetrated into hidden places that other weed killers (such as aromatic solvents) would pass by.

What did this chemical do? It destroyed the pond weeds for over 25 miles in a single application, and eliminated many other undesirable inhabitants of the canal, including snails and hosts of liver flukes which are harmful to farm animals. It lowered the water surface and made possible the delivery of more water to farms.

It was not difficult to follow its path. F–98 is strong, so strong, that one-fourth part per million in the atmosphere can be detected by anyone. Five parts per million in the air will drive a man away. The effect is like that of tear gas.

In strong solutions, F–98 is dangerous to crops, so it must ultimately be diluted or destroyed. In the Notus Canal experiment, all laterals were closed off and the water was confined to the canal and drains until the "slug" of F–98 had passed through. In conjunction with the weed killing experiment, crop tolerance tests were run on a variety of crops grown on the Black Canyon project. To summarize—what are the good and bad traits of F–98? The advantages:

(1) High efficiency for great distances.
(2) Excellent solubility in water.
(3) Speedy and positive action.
(4) Easy detection.

The disadvantages:

(1) Need for exceptionally careful handling (shipping in heavy drums, proper storage, careful application).

(2) In high concentrations, hazardous to crops and fish.

Will this product find a place in keeping canals and drains clean? Those of us who have experimented so far think so. Like the aromatic solvents which have been replacing the old inefficient and time-consuming systems of dragging with chains, this new weed killer is a time and labor saver. Two or three applications per year will keep canals weed-free. It has some definite advantages over aromatic solvents. It is a deadly killer, but one that can be controlled, and 1959 will see continued experiments to improve its effectiveness at concentrations which will not damage crops. Some progress on this has already been reported since the Notus tests. # # #

Mosquito Control

An interesting but little known aspect of Reclamation's work in California is mosquito abatement. At present the Bureau has contracts with six abatement districts for cooperative mosquito control on Government rights-of-way for Central Valley project canals and reservoirs. Through these contracts the Bureau reimburses abatement districts the moderate costs of the work they perform. In addition, field forces do considerable draining and filling of low spots to prevent mosquito development. The joint program has also reduced mosquito-borne diseases.

One Ditch System

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of the crops although some 40 commercial crops varying from truck to alfalfa are produced in the area. In fact, many of the operators, when asked about the effect of the relatively shallow water table during the irrigation season, claim advantages from subirrigation rather than any ill effects. It may be that the success of the system results from good quality water diverted from the Sacramento River, thus preventing a deleterious concentration from building up in any one season. Further, the average annual winter rainfall is about 15 inches. This quantity of water is probably sufficient to flush out any seasonal accumulation. In any case, if a concentration should build up in the lower part of the system, some fresh water could be shoved through the system or the system drained, thereby flushing out any accumulated salts.

While the one-ditch system is applicable only for special terrain and water supply situations it merits consideration for many locations where a two-ditch system is now in use. # # #

Typical farm pumping unit lifting water from one-ditch system. Note weed restricted to sides because of depth of water.

It takes only 50 years to wash down 7 inches of topsoil that has taken thousands of years to build up—*Twentieth Century Fund.*

CROP REPORT

The Bureau's annual crop summary reveals that a record high crop value of over $987 million was produced in 1958. The Reclamation crop amounted to about 5 percent of that of the U.S. as a whole in terms of value but was produced on only 2 percent of its cropland.

The Chief Joseph Dam and Michaud Flats Projects and the Glendo Unit of the Missouri River Basin Project initiated irrigation operations in 1958, bringing to 79 the number of operating projects.

The addition of 222 thousand acres to the irrigable service area of Reclamation projects brought the total to 8,049,642 acres. Of this, 6,756,737 acres were irrigated; the remainder being taken up in rights-of-way, farmsteads and other farm uses or awaiting leveling, ditching and other land development needs on the farms.

Full irrigation service lands comprised 4,256,301 acres of the irrigable area and were distributed among 57 projects. Supplemented irrigation service was provided to 35 projects. Thirteen of the projects included in each of the service categories included land areas which received both full and supplemental irrigation service.

The farms and cities which are provided water from Reclamation facilities represent homes and livelihoods for 9.7 million persons in the 17 Western States. Population on the 103 thousand full-time farms and 26 thousand part-time farms exceeds 490,000 persons. Urban encroachments on Reclamation projects have removed from farming use about 2 percent of the irrigable area. About 791,000 persons reside in these suburban fringe areas. Thirty-two projects provide municipal and industrial water service to some 106 municipalities and 68 industrial entities, benefitting directly about 8.4 million persons.

Visitors flocked to Reclamation reservoirs in greater numbers in 1958 than ever before. A total of 164 reservoirs received an estimated 19.5 million visitor days of recreational use. Peak day use exceeded one-half million persons. #

Flaming Gorge

Continued from p. 72

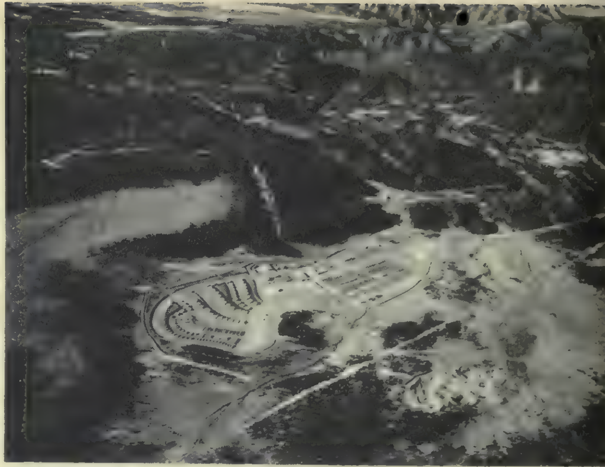
with an inside diameter of 26 feet and will be concrete lined to an inside diameter of 23 feet. It is 1,100 feet long. Open cut excavation at the inlet portal was started in the fall of 1958 and actual tunneling operations got underway about the first of January 1959. The diversion tunnel was holed through on March 2, 1959. Since then the subcontractor has completed the removal of the 5-foot invert segment of the circular tunnel, which was left in for a roadway, and the removal of tight projections of the rock. The excavation is now complete.

Arch Dam Constructors started the concrete lining of the diversion tunnel in May 1959 and expect to have this completed and be able to divert the flow of the Green River through the single diversion tunnel in August or September. Cofferdams will be constructed upstream and downstream of the dam and powerplant foundation areas in order to permit the unwatering of this portion of the river channel for construction of the dam and powerplant.

Concrete will be placed in the dam in 7½ foot lifts. The full length of the dam consists of 24 blocks, each block being about 50 feet in length. Placement of concrete will be by cableways 1,900 feet long extending from the left to the right abutment of the dam using 8 cubic yard buckets. The fixed headtower of the cableways will be located above the left end of the dam and the movable tailtowers, moving in an arc of 190 feet radius, will be located on the right side of the river. Two cableways will be used in placing the mass concrete in the dam.

The contractor's construction program calls for starting excavation of the spillway tunnel, located in the left abutment, in August. This work will continue throughout the remainder of the summer and through the winter. Placing of concrete in the dam is expected to start in June of 1960 and be completed in the late fall of 1962. Concrete placement will be restricted to the months of April through October of each construction season due to the freezing weather during the winter months. All work under the Arch Dam Constructors contract is scheduled for completion in July of 1963.

It is anticipated that reservoir storage will start in the fall of 1962. The first generating unit is scheduled to go into operation about the middle of the summer of 1963 with the remaining two units to follow at intervals of 3 to 4 months. All construction and installation of equipment for Flaming Gorge Unit is scheduled to be completed by the middle of the summer of 1964.



Aerial view of Dutch John, Utah, and surrounding area. *Photo by F. B. Slote.*

Many changes have been made in this isolated area in the northeast corner of Utah during the past 2 years. There are now nearly three times as many people living in Dutch John as previously inhabited the entire county of Daggett. By the middle of this summer good roads will be available to Dutch John and to the Flaming Gorge Dam from both Vernal, Utah and Green River, Wyo. Construction is in progress to provide visitors with easy access and excellent facilities from which to view the construction work in progress.

Diversion tunnel outlet, Flaming Gorge Dam. Outline is sketched on picture.

effect of fertilization on crop yields

by CARL W. CARLSON [1]

When land is placed under irrigation it is important that farm operators adjust crop production practices to take full advantage of irrigation water. If irrigation water is properly used, one of the biggest production variables, namely moisture, will be under control. Two other production factors which the farmer may control are fertilization of the soil and plant population. Both have a marked influence on yield.

Most of the information available on the effects of these two crop production variables has been obtained by studying these variables individually. In order to make recommendations to the farmer, the simultaneous effects of varying both fertilization and plant population should be known. For example, many experiments have been conducted to determine the value of commercial fertilizer on the production of corn. If the trial was conducted at a single plant population, the effect of nitrogen added was undoubtedly greatly affected by the plant population chosen.

As plant population increases the average yield of an individual plant decreases. Undoubtedly this is caused by a decrease in the supply of those production factors that each plant has to share with its competing neighbors. It has been found that when the number of plants growing on an acre of land is increased, the plant food requirement per acre is also increased. If maximum returns from high rates of fertilizer application are to be obtained, it is necessary to have a sufficient number of plants to efficiently utilize the fertilizer applied. However, there is a limit to the number of plants that can be grown on an acre even though the fertility level of the soil may be high. This limitation is brought about by factors other than soil fertility, such as light, becoming important.

A 3-year study with corn in North Dakota has shown that when no nitrogen fertilizer was applied, an increase in plant population resulted in an increase in silage yield but a decrease in grain yield. Similar work done in South Dakota showed a decrease in grain yield and no consistent effect on silage yield when plant populations were increased and no nitrogen was applied. At both locations this decrease in corn grain yields was apparently brought about by a deficiency of soil nitrogen.

When a medium application of nitrogen was used, an increase in the plant population resulted in some increase in both silage and grain yields. Applications of high amounts of nitrogen resulted in still larger silage and grain yield increases. High plant populations were necessary for maximum yields. There were no visual nitrogen deficiency symptoms at the higher nitrogen rate but some were evident at the medium nitrogen rate.

In all studies the weight of individual corn ears decreased as the plant population increased. Workers in Nebraska have shown that as the population increased over 14,500 plants per acre, ear weight decreased. One-half pound ears were produced with stands between 19,000 and 20,000 plants per acre. Barren stalks became a problem at high plant populations.

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[1] Soil Scientist, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Mandan, N. Dak.

Sugar beet roots harvested at Mandan. Both nitrogen and phosphorus were needed for maximum yields.

In Nebraska when large amounts of nitrogen were used, together with high plant populations, weak, slender stalks were produced. This resulted in lodging, which increased with increasing planting rates. On many of the plots with high plant populations, approximately half of the plants were lodged at harvest time.

According to the results reported here, irrigation farmers should plan for a minimum corn stand of 14,000 mature plants per acre. Kernels planted 11 inches apart in 40-inch rows result in such a spacing. Because it is generally assumed that about 85 percent of the kernels planted will produce mature plants, it is necessary to plant kernels about an inch closer than the desired spacing. Plantings made for silage or forage production should be spaced at 8 inches within the row (20,000 plants per acre).

Several workers have studied the fertility and spacing interactions with grain sorghums. In general the findings have been similar to those obtained with corn. Lodging and small head size became a problem when high plant populations were used. Maxium yield response of sorghum to high rates of fertilizer will require a minimum plant population of 45,000 plants per acre. Some workers have used populations up to 200,000 plants per acre without encountering too much difficulty.

Workers in Nebraska, studying the interaction of plant population and fertility with potatoes, found that the yield was increased by increasing the plant population. Nitrogen fertilizer gave yield increases only in plots having the highest plant populations. The highest yields and best quality potatoes were produced on treatments having 21,780 plants per acre.

Workers in North Dakota reported that a minimum of 20,000 plants per acre was necessary to obtain maximum benefit from fertilizer application.

Potato response to nitrogen fertilizer at Upham, N. Dak. Plant population was approximately 20,000 plants per acre.

Corn grain from sampled plot, Upham, N. Dak. Left to right: O nitrogen rate with 14,000 plants per acre. O nitrogen rate with 23,000 plants per acre. 120 pounds nitrogen per acre with 14,000 plants per acre and 120 pounds nitrogen per acre with 23,000 plants per acre.

Plant populations are important in sugar beet production also. In most cases maximum benefits have been measured only when populations above 20,000 plants per acre have been used. In many cases 25,000 to 30,000 plants per acre were required to obtain the highest yields.

Several workers have reported that crop varieties respond differently to nitrogen fertilization and variable plant populations. Studies with corn have shown that some hybrids do not respond to high rates of nitrogen fertilization, at high planting rates, while others do. Apparently the ability of individual corn plants to grow despite competition is partly governed by genetic factors.

With most crops, as the plant population was increased the maturity date was delayed. In an experiment in North Dakota with corn, as the population rate increased silking was delayed 1 day for each additional 4,000 plants.

For most crops studied, increasing the rates of nitron fertilization increased the number of plants required for maximum yield. In some cases the number of plants needed for maximum yield was doubled by nitrogen applications.

In summary it appears that under irrigation both fertilization and spacing must be at an optimum in order to obtain maximum yields. #

Plant population of 15,000 plants per acre and nitrogen fertilizer applied at a rate of about 100 pounds per acre as necessary for maximum corn yields under irrigation. *Photographs courtesy Department of Agriculture.*

Recreation

Continued from page 66

long of national interest. Existing recreation facilities in the reservoir area are limited, and recreation facilities will be needed on the shores of the reservoir to accommodate the many thousands of visitors to whom this outstanding scenic area will become accessible.

The Flaming Gorge unit is considered to be of national significance, and recreation planning includes two major development sites north of the national forest, on each side of the reservoir near the Utah-Wyoming State line.

Recreation development along the shores of the Navajo Reservoir will help meet the rapidly increasing needs for outdoor recreation in the San Juan River basin, an area long known for outstanding recreational appeal. The dam is being constructed in a deep canyon on the San Juan shortly below the mouth of its tributary, Los Pinos, and the reservoir located primarily in northwestern New Mexico will extend into Colorado. Major recreation development are proposed on each side of the reservoir a short distance from the dam. Among these is the Currecanti, a main unit of the development located in Colorado, which will consist of two or three principal dams creating reservoirs for additional recreation.

The recreational opportunities to be afforded by Reclamation reservoirs are discussed at only three such sites in this article. However, it is anticipated that the Colorado River Storage Project will provide similar opportunities at an estimated total of 15 reservoirs ultimately. These will be located in the States of Arizona, Colorado, New Mexico, Utah, and Wyoming.

The phenomenal recreational use of reservoirs indicates that these recreation developments will result in significant monetary benefits to the surrounding area, as well as providing substantial recreation opportunities. # # #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5133	Middle Rio Grande, N.M.	May 6	Channelization of the Rio Grande, Albuquerque Area, Unit 3.	Boswell Construction Co. Albuquerque, N.M.	$284,845
DC-5135	Columbia Basin, Wash.	April 10	Construction of earthwork and structures for Block 83 laterals, Royal Branch canal laterals.	Otis Williams and Co. Kennewick, Wash.	478,811
DC-5139	Colorado River Front Work and Levee System, Ariz.	April 6	Construction of earthwork, pipe lines, and structures for South Gila Drain No. 2.	Vega Engineering and Grading Co. Berkeley, Calif.	188,111
DS-5141	Missouri River Basin, Minn.	April 13	Three 230-kv power circuit breakers for Granite Falls substation, Schedule 1.	Brown Boveri Corp. New York, N.Y.	212,225
DC-5144	Missouri River Basin, Wyo.	May 11	Completion of Fremont Canyon powerplant	Flora Construction Co. and Argus Construction Co. Denver, Colorado.	575,773
DC-5155	Collbran, Colo	April 17	Construction of earthwork and structures for Southside canal, Sta. 18+95.46 to 1146+49, Schedules 1 and 4.	Vitro Corp. of America, Refinery Engineering Company Division, Farmington, N.M.	1,598,349
DC-5156	Missouri River Basin, N. Dak.-Minn.	April 28	Stringing conductors and overhead ground wires for 165 miles of Fargo-Granite Falls 230-kv transmission line.	Midland Constructors, Inc. Chicago, Ill.	1,524,647
DC-5160	Central Utah, Utah	May 4	Construction of Stanaker Dam	Morrison-Knudsen Co., Inc. Salt Lake City, Utah.	1,658,834
DC-5148	Missouri River Basin, Neb.	April 15	Construction of earthwork and structures for Culbertson canal.	Bushman Construction Co. St. Joseph, Mo.	751,461
DC-5150	Central Valley, Calif	April 7	Construction of earthwork, structures, and bituminous surfacing for relocation of Trinity County road.	Ray Kizer Construction Co. Portland, Ore.	613,735
DC-5161	Collbran, Colo	May 22	Construction of Upper and Lower Molina powerplants, penstocks, and equalizing reservoir.	Vitro Corp. of America, Refinery Engineering Company Division, Farmington, N.M.	2,425,247
DC-5166	Missouri River Basin, Mont.	May 15	Construction of earthwork and structures for North Side and East Side laterals, sublaterals, and drains.	A and B Construction Co. Helena, Mont.	1,242,448
DC-5167	Columbia Basin, Wash.	May 4	Construction of earthwork, concrete lining, and structures on Wahluke Branch canal laterals.	Triangle Construction Co. and George L. Thompson Kennewick, Wash.	589,263
DC-5169	Missouri River Basin, Wyo.	June 10	Construction of 140 miles of Kortes-Cheyenne 115-kv transmission line.	Hoak Construction Co. West Des Moines, Iowa.	1,513,368
DC-5171	Missouri River Basin, Wyo.	May 26	Construction of 37.3 miles of Boysen-Pilot Butte 115-kv transmission line.	Pacific Electrical and Mechanical Co., Inc., Los Angeles, Calif.	386,952
DC-5172	Central Valley, Calif	May 25	Furnishing and installing trash removal equipment for fish collecting facilities at Delta-Mendota intake canal.	Hart and Hynding, Inc., San Francisco, Calif.	206,850
DC-5177	Missouri River Basin, N. Dak.	June 12	Constructing foundations and furnishing and erecting steel towers for 100 miles of Bismarck-Jamestown 230-kv transmission line No. 2.	Midland Constructors, Inc., Chicago, Ill.	1,447,700
DC-5178	Middle Rio Grande, N. Mex.	June 1	Channelization of the Rio Grande	Boswell Construction Co., Albuquerque, N. Mex.	345,310
DC-5181	Central Valley, Calif	June 19	Construction of Corning canal pumping plant, etc	Hood Construction Co. and F. W. Case Corp., Whittier, Calif.	824,082
DS-5184	Lower Rio Grande Rehabilitation, Texas.	June 17	Three natural gas engines for pumping plant on the Rio Grande.	Worthington Corp. Harrison, N.J.	223,430
DC-5185	Weber Basin, Utah	June 5	Construction of the second stage of Willard Dam	George M. Brewster and Son, Inc., Bogota, N.J.	4,606,260
DC-5186	Collbran, Colo	June 8	Construction of earthwork, pipe lines, and structures for Bonham and Cottonwood pipe lines.	Davis and Butler Construction Co., Salt Lake City, Utah.	1,669,359
DC-5191	Milk River, Mont	June 26	Rehabilitation of Sherburne Lake Dam outlet works	Winslow-Huckaba Co., Whitehall, Mont.	168,677
DC-5198	Rogue River Basin, Oreg.	June 19	Construction of earthwork and structures for South Fork and Daley Creek collection canals.	H. Barnhart and Leonard R. Ward, Medford, Oreg.	499,438
DC-5199	Central Valley, Calif	June 24	Furnishing and installing armature windings at Shasta powerplant.	General Electric Co. Denver, Colo.	462,664
117S-551	Columbia Basin, Wash.	Apr. 23	Aerial photographs and topographic maps for 151,000 acres of East High canal.	Land and Air Maps, Inc., Maumee, Ohio.	149,370
200C-407	Central Valley, Calif	Mar. 31	Clearing 1,655 acres of Trinity reservoir site	Hubner and Michner, Inc., Denver, Colo.	350,000
200C-407	Central Valley, Calif	Mar. 31	Clearing 3,310 acres of Trinity reservoir site	J. H. Trisdale, Inc., Redding, Calif.	553,350
200C-411	Central Valley, Calif	May 28	Construction of earthwork, structures, and bituminous surfacing for Whiskeytown dam access road.	H. Earl Parker, Inc., Marysville, Calif.	350,359
400C-133	Colorado River Storage, Utah-Wyo.	June 17	Clearing 6,800 acres of first phase of Flaming Gorge reservoir site.	Herman H. West and Co. and Phillips and Jordan, Robbinsville, N.C.	2,385,000

Construction and Materials for Which Bids Will Be Requested Through September 1959*

Project	Description of work or material
Central Valley, California.	Constructing about 13.7 miles of lines for hydrostatic heads. Tea Pot Dome laterals, near Porterville.
Do	Earthwork, structures, and bituminous surface treatment for about 6 miles of county road from Swift Creek to Carrville.
Do	One hoist, stems, and support beams for fixed-wheel penstock gate for Trinity dam.
Collbran, Colo	Earthwork and structures for about 11.5 miles of bottom width unlined canal and about 0.1 mile of earth-lined canal. Southside canal, near Collbran.
Do	One 9,600-kva, 600-rpm, 0.9 power factor, 4,160-volt, horizontal-shaft generator for Upper Molina powerplant; and one 5,400-kva, 450-rpm, 0.9 power factor, 4,160-volt, horizontal-shaft generator for Lower Molina powerplant.
Colorado River Storage, Arizona.	Six 7- by 10.5-foot outlet gates, liners, and anchor bolts for Glen Canyon dam.
Do	Eight 155,500-hp, Francis-type hydraulic turbines for Glen Canyon powerplant.
Columbia Basin, Washington.	Earthwork and structures for about 6.7 miles of concrete-lined laterals, about 12 miles of compacted earth-lined laterals, about 1.5 miles of unlined laterals, about 16.5 miles of open-ditch drains and wasteways, about 5,000 feet of closed drains, 1,000 feet of pipe chute, and a small outdoor-type pumping plant.
Do	Compacted blended earth lining about 7.5 miles of Royal Branch canal and laterals.
Do	Constructing eight 2-bedroom frame residences.
Crooked River, Oregon.	Earthwork, structures, and crushed-rock surfacing for about 7 miles of highway from Prineville dam to Bear Creek.
Gila, Ariz	Constructing 1,350 feet of precast concrete pipe bypass lines with open flow meters and slide gates for Wellton-Mohawk pumping plants.
Fort Peck, Mont. and MRB, North Dakota.	Furnishing and stringing 954,000 circular mil, ACSR conductors and 0.5-inch steel overhead ground wires for the 304 miles of Fort Peck-Dawson County and Dawson County-Bismarck 230-kv transmission lines.
Lower Rio Grande Rehabilitation, Texas.	Rehabilitating about 5.2 miles of lateral will include reshaping the prism and banks and constructing unreinforced concrete lining with bottom widths of 5 and 3 feet in the new section.
Middle Rio Grande, New Mexico	Constructing 13 structures including culverts, siphons, checks, drops, wasteways, and turnouts south of Belen.
Minidoka, Idaho	Constructing Unit A relift pumping plant, discharge line, and a small reservoir. Ten miles southwest of Paul.
MRB, Kansas	Earthwork and structures for about 12 miles of 10- to 3-foot bottom width canal, and about 12.5 miles of 3-foot bottom width laterals. Osborne canal, near Osborne.
Do	Earthwork and structures for about 6.4 miles of canal and about 6.9 miles of laterals, including the 2-mile-long, 42-inch-diameter Republican River siphon. White Rock extension, near Republic.
MRB, Minnesota	Stage 04 additions to the Granite Falls substation will consist of constructing concrete foundations, furnishing and erecting an extension to the existing steel structure and minor new structures, installing three 230-kv circuit breakers, one 15,000-kva reactor and associated switches and other electrical equipment, major items of which will be Government-furnished.
MRB, Nebraska	Earthwork and structures for about 9 miles of 16- to 12-foot bottom width Culbertson extension canal. Work will include siphons with alternate schedules of monolithic or precast concrete pipe. Near Culbertson.
MRB, South Dakota	Stages 03 and 04 additions to the Huron substation will consist of regrading and fencing the existing area, constructing concrete foundations, furnishing and erecting steel structures, and installing a 60,000-kva bank of single-phase, 230/115-kv autotransformers.
MRB, Wyoming	Constructing the Gray Reef dam, about 2.5 miles downstream from Alcova dam.
Do	Constructing one mile of tile for closed drain and about 2 miles of open drains, Hanover-Bluff Unit, south of Worland. (Readvertisement of Specifications No. 601C-59).
North Platte, Wyoming	Constructing a rock-lined inclined drop structure about 60 feet wide by 115 feet long on Cherry Creek drain.
Rogue River Basin, Oregon	Constructing a 30-inch-diameter siphon on West lateral. Billings siphon, near Ashland.
Do	Constructing the Phoenix diversion dam will consist of a reinforced concrete floor slab with piers for a flashboard controlled crest and appurtenant training and retaining walls, on Bear Creek, near Talent.
Do	Constructing 12 siphons with a combined length of about 2,750 feet. Work will include constructing turnouts and wasteways, near Ashland.
Weber Basin, Utah	Earthwork and structures for about 2.4 miles of unlined open-ditch laterals and about 2.8 miles of pipe laterals. Wood Cross laterals, near Salt Lake City.

*Subject to change.

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v. 45, no. 4

The Reclamation Era

NOVEMBER 1959

IN THIS ISSUE:

- **Phreatophytes—Water Wasters**
- **Key Changes in Bureau Offices**

Official Publication of the Bureau of Reclamation

The Reclamation Era

NOVEMBER 1959 **VOLUME 45, NO. 4**

In this issue . . .

J. J. McCARTHY, Editor

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PHREATOPHYTES—water wasters
—*a menace in the arid west*[1]

PHREATOPHYTES—plants that habitually obtain their water supply from the ground water table (zone of saturation) or the capillary fringe above it—are causing great concern in irrigated areas of Western United States, especially in the Southwest. In many places these plants constitute the principal vegetation along irrigation and drain canals, around reservoirs, along streams and on flood plains in the arid West. They interfere with water flow and canal maintenance, clog stream channels, create flood hazards, and "pump" enormous quantities of precious water from the ground water reservoir into the dry air.

The U.S. Geological Survey estimated in 1957 that undesirable phreatophytes cover 15 million acres of bottomlands in 17 Western States and use nearly 25 million acre-feet of water annually. The Geological Survey and the U.S. Soil Conservation Service estimated that it would be practicable to save 25 percent of this wasted water for beneficial uses by stream channelization and effective control of phreatophytes. This would provide an additional 6¼ million acre-feet of water for irrigation, power development, and industrial and potable uses. Allowing 25-percent loss between the reservoirs or diversion dams and the irrigated farms this would leave over 4⅔ million acre-feet of salvaged water that could be delivered to cropland. [This was more water than was delivered in 1957 to all of the land that was irrigated on the Imperial, Calif.; Salt River, Ariz.; Boise, Idaho; and Columbia Basin, Wash.; projects combined, which had a total of 1¼ million acres of land under irrigation. The total gross value of crops on these projects for 1957 was nearly $228 million. Ed.]

Federal and State agencies concerned with conservation of water, maintenance of irrigation and drainage systems, and prevention of floods in the West have been making a concerted effort to find means for combating the rapidly spreading phreatophyte menace.

by F. L. TIMMONS[2]

[1] Investigations conducted cooperatively by the U.S. Department of Agriculture, Research Service, Crops Research Division and the Wyoming Agricultural Experiment Station.

[2] Research Agronomist, Crops Research Division, ARS, U.S. Department of Agriculture.

Kinds of Phreatophytes

Undesirable phreatophytes are found in all parts of the United States, but the problems they cause are most critical in the West. The plants most commonly classified as undesirable phreatophytes are salt cedar (*Tamarix pentandra*), willow (*Salix spp.*), baccharis (*Baccharis glutinosa*) velvet mesquite (*Prosopis juliflora*), and greasewood (*Sarcobatus vermiculatus*). All of these are trees or shrubs.

The phreatophytes are a group of plants containing genera or species from a number of different plant families. The most varied genus is willow (*Salix*), which contains more than 100 different species ranging from the black willow, a tree reaching heights up to 60 or 70 feet, to small shrubs such as button willow, which grows along mountain streams or lakes at elevations above 8,000 feet. Willows are found in all parts of the United States. The closely related genus, *Populus* (cottonwood, aspen, and poplars), contains many species of trees, which occur in various parts of the United States. Many species of *Tamarix* are found in southern Asia, northern Africa, and southern Europe but only a few species have been introduced into North America. Only the *Tamarix* species known as salt cedar has escaped to become a serious problem. Other plant families are represented among the phreatophytes by only one or two species.

While most phreatophytes are undesirable, a few are valuable crops or ornamentals. One notable example of a beneficial phreatophyte is alfalfa, the most valuable hay-crop plant in the United States. Other beneficial phreatophytes are certain species of willow, cottonwood, poplar, and tamarisk, which are shade trees or ornamentals.

Heavy Users of Water

Most of the phreatophytes grow best when the ground water table or capillary fringe above it is only 6 to 10 feet below the surface. However, salt cedar, willow, cottonwood, and greasewood will extend their roots 15 to 20 feet deep and mesquite has been known to send its roots 40, 50, or even 100 feet to water. On the other hand, willow and salt cedar grow luxuriantly at or just above the waterline along canals and reservoirs. They have been observed to survive several months with up to 50 percent of the above-ground growth submerged by water.

Phreatophytes are notoriously heavy users of water. The ground water level in some localities declines during the day and rises at night with clocklike regularity because of the high water requirements of these plants. In a study by the U.S. Geological Survey, water consumption by phreatophytes during a 12-month period from 9,303 acres

Excavating deep and narrow conveyance channels through dense thickets of phreatophytes on river flood plains have resulted in important savings of water.

A truck-mounted high-pressure sprayer and spray gun are suitable equipment for making high volume spray applications of 2,4-D on willows and other phreatophytes along canals with access roads (Bureau of Reclamation, Region 6).

along a 46-mile stretch of the Gila River flood plain in Arizona amounted to 28,000 acre-feet, an average of about 3.0 acre-feet an acre. The density of the vegetation over the area studied was about 52 percent. If the density had approached 100 percent, which occurs in some infestations, the annual consumption would have been much higher. Tank experiments at Saffard, Ariz., showed a total water use of 7¾ acre-feet per acre of salt cedar with the depth of water table 6 feet below the surface. From studies made by the U.S. Department of Agriculture, the National Resources Planning Board concluded that the average annual consumption of ground water on the Pecos River Delta above McMillan Reservoir, occupied by a dense growth of salt cedar, was about 5.0 acre-feet per acre.

Salt Cedar Spreading Rapidly

Salt cedar is the most aggressive and notorious of the undesirable phreatophytes. This species, which is indigenous to north Africa, southwest Asia, and India, probably was brought to America by the early Spanish explorers. It has been distributed throughout the United States for ornamental planting in parks and around homes. Since about 1930 it has spread rapidly along streams and canals in Arizona, New Mexico, Texas, Oklahoma, and the southern parts of Colorado, Utah, Nevada, and California. Recently, salt cedar has been reported growing in nearly every natural watercourse in these areas at elevations below 5,000 to 6,000 feet. At higher elevations and in colder climates the plant occasionally occurs but does not spread as rapidly, and does not dominate a plant community as at lower elevations and in warmer climates. However, during the past 5 years, rapidly spreading infestations have been observed in Oregon, Wyoming, western Nebraska, and west-central Kansas. Ecological studies are underway in north-central Wyoming and west-central Kansas to determine if possible whether salt cedar is potentially a serious problem on tributaries of the Missouri River and perhaps on the entire Missouri River System.

Control by Mechanical Methods

Most woody phreatophytes are "root sprouters" and are difficult to control by mechanical means alone. Root and crown sprouts which develop following mowing, bulldozing, discing, sawing off, grubbing and/or burning, usually grow to a height of 6 to 8 feet the first year after mechanical clearance. The mechanical treatment must be repeated one to three times each year to maintain control and such repetition is expensive. The cost may be $25 or more per acre for mechanical clearing of mature phreatophyte growth. The cost of mechanically controlling regrowth usually ranges from $3 to $6 per acre annually, depending upon the method used. Where the land is leveled for irrigating and growing crops after clearing off phreatophyte growth, the cost of clearing and leveling may total as much as $80 per acre. Despite the high cost, mechanical methods are being used on thousands of acres by the Bureau of Reclamation, the New Mexico State Engineer's Office, the U.S. Boundary Commission in New Mexico and Texas, and the U.S. Fish and Wildlife Service to control phreatophyte growth in strategic conveyance channels and floodways, on levees and canal banks and on critical feed-producing areas in wildlife refuges.

Channelization Saves Water

Excavating deep and narrow conveyance channels through dense stands of phreatophytes and mechanically clearing phreatophytes from broad floodway channels have resulted in important savings of water. A conveyance channel 6.2 miles long through dense salt cedar on the Pecos River flood plain above McMillan Reservoir near Carlsbad, N. Mex., at a cost of $64,697 prevented much of the earlier losses of water released from the upstream Alomagordo Reservior into the downstream McMillan Reservior for irrigating purposes.

Dense mature "jungles" of salt cedar are accessible for spraying with 2,4-D only by airplane (Bureau of Reclamation Region 3).

Channelization and floodway clearing through dense phreatophyte growth on a 35-mile stretch of the Rio Grande above Elephant Butte Reservoir at a cost of $1,463,000 salvaged an estimated 200,000 acre-feet of water from 1951 to 1956. The future annual salvage is estimated as 45,000 acre-feet. In another 40-mile reach of the river the annual salvage resulting from channelization is about 40,000 acre-feet. Keeping these conveyance channels and floodways free from obstructive phreatophyte growth is a continuing problem requiring mechanical or chemical treatment one or more times each year.

Control by Chemicals

Some phreatophytes can be controlled effectively by spray applications of 2,4-D at rates of 1 to 3 pounds per acre. Most species of willow can be eradicated by 1 or 2 foliage spray applications of 2,4-D in high volumes (100 or more gallons of water per acre) applied by ground spray equipment or in low volumes (5 to 10 gallons per acre of water or oil-water emulsion) applied by airplane or helicopter. Dormant sprays with 2,4-D applied in oil or oil-water emulsion in late fall or early spring are also effective on willows. Cottonwood is somewhat more resistant than willows to 2,4-D, but it usually yields to repeated treatments. Velvet mesquite is resistant to 2,4-D but can be controlled by high- or low-volume foliage spray applications of 2,4,5-T.

Where tall phreatophytes on canal banks or levees are killed by chemical treatment, a problem of clearing off the dead brush and tree growth usually remains. Some agencies, for example, the Bureau of Reclamation Region 5, which comprises New Mexico, western Texas, and western Oklahoma, and Region 6, which includes Montana, the western Dakotas, and north central Wyoming, have found it more convenient and less expensive to clear off the live growth before spraying with 2,4-D. In Region 6, willows, cottonwood, and wild rose are bulldozed off during the winter when the ground is frozen and the plants are easily broken off at the surface. The luxuriant sprout growth which develops the following year is then easily killed by 2,4-D applied in late summer. Where wild rose is present, a mixture of 2,4,5-T and 2,4-D is used.

Salt Cedar More Difficult

Salt cedar has been successfully eliminated from irrigation ditchbanks and similar areas by two or three repeated spray applications of 2,4-D at 2 to

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GUY C. JACKSON

FLOYD E. DOMINY

NRA CONVENES IN DENVER

As this issue went to press the 28th Annual Convention of the National Reclamation Association was scheduled to be held at the Shirley Savoy Hotel, Denver, Colo., on Wednesday, October 28, continuing through October 29 and 30.

Secretary-Manager William E. Welsh arranged the preliminary plans for the convention after conferring with President Guy C. Jackson and other officials of the Association from the various Western States. Indications were that the meeting would include nationally known authorities in the field of water resource development.

National Reclamation Association President Jackson was scheduled to deliver the principal address.

One of the highlights of the convention was to be a tour to the new $150 million Air Force Academy at Colorado Springs, which was officially dedicated and held its first commencement earlier this summer.

In addition to President Jackson, others scheduled to address the convention included leading members of the House and Senate Interior and Insular Affairs Committees; Gov. Steve McNichols of Colorado; Wm. E. Richards, President of the National Association of Soil Conservation Districts; and Reclamation Commissioner Floyd E. Dominy.

Other Interior and Reclamation officials in attendance at the annual convention of the N.R.A. were Assistant Secretary—Water and Power Development, Fred G. Aandahl; Assistant Commissioners N. B. Bennett and W. I. Palmer of Reclamation; Associate Solicitor, Water and Power, Edward W. Fisher; assistant to the Commissioner-Information, Ottis Peterson; Chief Division of Irrigation and Land Use, Gilbert G. Stamm; and Chief, Division of Project Development, D. R. Burnett.

A discussion on Federal-State relations in the field of water rights between Assistant Attorney General Perry W. Morton of the Justice Department, representing Attorney General Rogers, and former Under Secretary of the Interior Hatfield Chilson promised to be another key feature of the convention.

Last minute developments indicated such top speakers as Senators Gordon Allott and John A. Carroll of Colorado; Marshall N. Dana, charter member of the NRA and the Association's first president (1932–35); Dr. Cecil H. Wadleigh, member of the Agricultural Research Service, Soil and Water Conservation Research Division of the U.S. Department of Agriculture; and Richard W. Batterton, mayor of Denver, were anticipated at the meeting.

will chemistry reduce seepage losses?

October 29, 1957, may prove to be a historic date for irrigation in the West. As the sun's early rays shone across the desert and sand dunes of the Imperial East Mesa in California, pumps were started, a valve turned and a flow of a gray-green substance about the consistency of diesel fuel was released into 400 c.f.s. of water flowing in the Coachella Canal of the All-American Canal System. What was this peculiar substance, where did it come from, and what was it supposed to do were questions in the minds and on the lips of observers to this unique performance in the desert wastes of Southern California.

The whole story is a long one and is filled with many discouraging pages, but the villian of the plot is an insidious robber called seepage. In past years a certain amount of seepage has been an accepted fact, but as more people and industries come West the water losses that previously could be tolerated will be of prime importance to the very existence of man in the Far West.

When water was plentiful great canals were built in the natural earth formation without impervious linings and seepage took its toll because lining cost more than water. Several years ago the Imperial Irrigation District, the Coachella Valley County Water District, and the Bureau of Reclamation recognized that seepage losses of large magnitude from the Coachella and All-American Canals could not continue indefinitely. Study was given to corrective measures that would not require a positive lining since the canal system is in use the year round. Bentonite and montmorillonite clays were investigated and found unsuitable because of the large amount of calcium sulphate or gypsum in Colorado River water.

The milky appearance of the irrigation water is caused by SS—13 which is being applied to a plot of sandy soil on the Yuma Mesa Unit of the Gila Project in Arizona. In this instance the SS—13 is being tried experimentally to see if it will (1) reduce infiltration rate and thereby permit a more uniform spread of the water over the sandy surface, or (2) increase water-holding capacity thererby inceasing the period between irrigations. *(Photo by Maurice N. Langley, formerly of Region 3.)*

During this search for a sealant a chemist for the Brown Mud Co., Torrance, Calif., who specialized in the chemistry of drilling muds for oil wells, requested and was given permission to work with the soils of the Coachella Canal to see if a certain chemical preparation might be used to reduce seepage. For the next 6 to 8 months there were stories about men taking soil samples and carrying them away, and of the installation of peculiar gadgets in the sides of the canal.

Finally came October and letters of invitation to observe a trial canal treatment on October 29. Irrigation engineers from Arizona, Nevada, Colo-

by C. L. SWEET, Bureau of Reclamation, Region 3, Boulder City, Nev.

rado, and California were present, and as the valves were turned and the greenish-gray material flowed into the water and formed a river of milk, there was but one question, "What is it?" The answer, "SS–13." "What is it supposed to do?" The answer, "Reduce seepage losses."

Time passed. It developed that inflow-outflow measurements of a canal carrying up to 1,500 c.f.s. could not be made precise enough to determine seepage changes in an 8-mile section of an 82-mile-long canal. For this reason it became apparent that no conclusions could be drawn as to how much, if any, water was saved. However, there were two significant indications. An observation well in the bank of the canal with a continuous recorder showed a water level difference between the water level in the recorder well and the level of the canal of about 0.2 foot before treatment. After treatment the difference in water levels varied from 1.5 to 3.2 feet, depending upon the elevation of the water in the canal. The second significant indication was the fact that operating records showed a larger percentage of water reaching the Coachella Valley distribution system than in previous years.

These indications were sufficient to interest the Salt River Valley Water Users' Association, Phoenix, Ariz., in a test to determine exactly how much water an application of SS–13 would save. An agreement was made among the association, Arizona State University, Tempe, Ariz., and the Bureau of Reclamation to make such a test.

The South Canal of the Salt River project has a design capacity of 1,200 c.f.s. and was lined with pneumatically applied concrete about 30 years ago. The only value of the lining at present is for erosion control as extensive cracking has destroyed any significant value against seepage losses. This canal was chosen for several reasons, one of which was that it represented a canal comparable in size to the Coachella Canal and some data for comparison might be obtained.

In November 1958, a 4,000-foot section of the South Canal was cleaned of all sand and a retention dam faced with polyethelyne plastic was constructed at each end of the test section. The section was ponded between November 22 and 24. Seepage losses were found to be 0.928 cubic foot per square foot per day for a total loss of 7.11 acre-feet per day. The ponded water was released and the section filled with water containing 670 p.p.m. of SS–13 which was ponded for a period of 72 hours. The seepage losses after treatment were found to be 0.382 cubic foot per square foot per day for a total loss of 3.08 acre-feet, or a reduction of about 59 percent in seepage losses. The ponded water was released, the dams removed, and the canal placed in normal service.

During the first week in February 1959, the canal was again emptied and the dams reconstructed as in November. The test section was refilled and ponded between February 8 and 11. The results showed seepage reduction of approximately 60 percent, as compared to 59 percent in November. This difference is within the limits of accuracy of the test and it is concluded there was no change. It is planned to again duplicate this ponding test this month to obtain factual data as to the length of time the treatment is effective.

What is SS–13, what do we know about it, and what does it cost to treat a canal? It consists of resinous polymers and heavy atoms mixed in a carrier of common diesel fuel. Its function is to increase the ionic attraction of the soil particles for water, thus increasing the thickness of the hygroscopic envelope of water around each particle. This decreases the voids or passage through which water can move and reduces the flow through the soil. We know it is no more pleasant to drink than a mixture of diesel oil and water. It is harmful to fish, few animals like it, and people shouldn't. Cost of treatment will vary with every installation, but was about $0.07 per square yard on the Coachella Canal test and $0.217 per square yard at Phoenix. However, it should be recognized that the Phoenix test was a research project in which 90 percent of the material was wasted with deliberate intent and the construction of retention dams is not required for normal application. Therefore, normal cost of application should be much lower than experienced in these research projects.

Will chemistry reduce seepage? It has been proved that chemistry will reduce seepage by about 60 percent in a large canal at Phoenix, Ariz., of the canal there was no change. The feeling of the cooperators on the Phoenix tests is one of cautious optimism. Will October 29, 1957, be a date of historical significance to the irrigated West? Data being obtained should produce rather definite conclusions within the next year. Are we at last about to back the seepage villain into a corner? The next episode should provide the answer. # # #

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Commercial Fertilizers in Neutral and Alkaline Soils of the West [1]

Drilling winter barley and banding fertilizer in one operation on land irrigated under sprinkler system.

Misconceptions and lack of information about fertilizer application cost American farmers thousands of dollars each year. Fertilizers commonly are broadcast or banded on the plow sole during land preparation; broadcast on the soil surface before or during seedbed preparation; band placed at various depths before or at planting; sidedressed after plant emergence; topdressed on pastures, cereals, or other densely populated crops; applied in irrigation water; or sprayed upon foliage of growing plants.

Commercial fertilizers are available as liquids, solids, or gases. The use of a given type depends upon method of application, availability, price, effectiveness, ease and cost of storage.

Liquid fertilizers usually are corrosive requiring special storage facilities. Dilution of solid material with water lowers their analysis. This may increase cost of transportation, storage, etc. The extra weight may compact soils if tanks are hauled through fields for fertilizer distribution. Solid or dry materials are easily and cheaply stored in paper or waterproof bags, but may tend to solidify with time when stacked too high, or if material becomes moist. Anhydrous ammonia, the principal gaseous fertilizer used, is of very high analysis, but storage tanks must be heavy to withstand pressures involved. Fertilizer dealers often supply equipment for distributing their product, whether liquid, solid, or gas.

Fertilizer materials in various forms may supply one or more nutrients needed by plants. For instance calcium nitrate, sodium nitrate, ammonium sulfate, ammonium nitrate, urea, anhydrous ammonia and other forms supply supplemental commercial nitrogen. Ammonium phosphate, 11–48–0, provides 11 percent nitrogen and 48 percent phosphate, whereas 10–10–5 furnishes 10 percent

by DR. CHAUNCY O. STANBERRY [2]

[1] Contribution from Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Arizona Agricultural Experiment Station cooperating.

[2] Soil Scientist, Western Soil and Water Conservation Research Division, U.S. Department of Agriculture, University of Arizona, Tucson, Ariz.

nitrogen, 10 percent phosphate, and 5 percent potash. Costs of a needed nutrient source for a given method of application, cost of application itself, and effectiveness vary among the different available materials and methods of application. Total cost per unit of required nutrient is commonly accepted for deciding which material to purchase. Total cost per effective unit of required nutrient applied should be the most efficient basis for deciding which source to utilize.

Two nutrients most commonly need in irrigated soils of the West are nitrogen and phosphorus. Sometimes micronutrients such as boron, zinc, and molybdenum are needed also, but usually only in minute quantities. The Agricultural Extension Service and Agricultural Experiment Station usually can supply information on rates and methods of application, when to fertilize, etc.

Nitrate nitrogen moves vertically with the water applied, though ammonium nitrogen, phosphorous and most other nutrients move little or none with water. Even on the soil surface nitrate nitrogen moves little laterally unless water flow moves soil particles. Rapid surface evaporation in sandy soils, and retardation of root activity where soil temperatures become excessive, may leave surface-applied ammonium, phosphate, and other less mobile nutrients, positionally unavailable to plants. Ammonium sources may oxidize to nitrates before a subsequent irrigation and then be carried into the root area in solution. Phosphates are immobilized quickly, but remain available if in contact with plant roots, for at least several years in many neutral and alkaline soils of the West.

BROADCASTING OR BANDING ON THE PLOW SOLE DURING LAND PREPARATION usually places the fertilizer sufficiently deep in moist soils to be positionally available to many plant roots despite surface evaporation. However, a disadvantage is the increase in necessary work and time for plowing. Smaller fertilizer equipment available for use with plows requires repeated filling, and area covered per unit of time is much less than with conventional broadcasting equipment. Some fertilizer applied may not be positionally available since application is made without reference to future plant positions. To insure an adequate supply for crops, a higher rate may be necessary than for fertilizer sidedressed only along each plant row. Since all fertilizer is at the plow depth, in very infertile soils plants may grow slowly and be stunted before their roots reach needed nutrients.

Fertilizer Placement and Planting Equipment—Belt applicator on each side of tractor will apply one, two, or three bands of dry fertilizer each to depths of 7 inches. Planting equipment immediately behind fertilizing equipment will plant a maximum of eight rows (four on each side of tractor) of seed (*Agricultural Research Service, Yuma, Ariz.*).

BROADCASTING FERTILIZERS ON SOIL SURFACES BEFORE OR DURING SEEDBED PREPARATION with adequate incorporation is one of the cheapest and most effective methods of application. Good broadcasting equipment satisfactorily and inexpensively distributes fertilizer on soil surfaces for incorporation. With the large capacity of wide broadcasting now available, fillings are infrequent and much land may be fertilized in a short while. Plowing to 6 inches or more following broadcasting places much of the fertilizer near the plow depth available to plant roots. Smaller amounts are scattered through the soil to the surface giving young shallow rooted plants an early supply. If the soil is bedded for planting or transplanting, broadcasting needed nutrients just before the bedding operation often is more effective than banding within the bed.

Disadvantages include an additional operation for application, only partial positional availability with incomplete root distribution, and only solid or liquid fertilizers may be utilized, though gaseous ammonia may be less expensive. Also, drying of calcareous soils which have received ammonium fertilizers may result in considerable nitrogen loss by volatilization.

BAND PLACEMENT AT VARIOUS DEPTHS BEFORE OR AT PLANTING leaves water-mobile fertilizers less subject to leaching than broadcast applications because less water contacts each unit of fertilizer. Band

placement of immobile nutrients at appropriate depths permits them to remain in moist soil and be accessible to roots. Sometimes banding fertilizers gives superior results in dense fine-textured soils where inadequate fertility, aeration, mechanical impedance, or plant rooting habit limit root distribution. Even in friable fertile soils short season crops or very young plants at first may respond better to band applications because of limited root distribution. Response for the entire season, however, usually is not superior to broadcast applications.

Band placement of phosphates became popular in acid soils of the eastern United States because some of the banded material remained available to plants. Broadcast applications giving greater fertilizer surface contact per unit of soil were entirely precipitated as iron and aluminum phosphates which are less available to plants.

Banding in neutral and alkaline soils often is less effective than broadcasting and incorporating the same nutrients. For instance, broadcasted water-soluble phosphates in calcareous soils may be dissolved in water and moved a short distance in solution before reprecipitating to give a large surface area of sparingly water-soluble calcium phosphates. Though of low water solubility, however, these phosphates may be adsorbed by plant roots if surface contact is great between root and phosphate.

SIDEDRESSING GROWING PLANTS may be accomplished during cultivation operations It is a type of banding, and may be especially beneficial for short season crops, those with limited root distribution, or in compact fine-textured soils. Since applications are close to plants, less fertilizer may be required than when broadcast over the soil surface or banded before seeding and plant establishment. Caution must be exercised to prevent root pruning with the sidedressing equipment, or "burning" of tender rootlets by fertilizer applied too closely.

Fertilizer application by topdressing on pastures, cereals, and other densely populated crops, or in irrigation water is relatively inexpensive. Also, liquid, solid, or gaseous types of fertilizers may be used. Unless feeder roots are active very near the soil surface, however, ammonium and phosphate sources topdressed or applied in irrigation water are not fully utilized during the year because of positional unavailability. In coarse unstratified soils the minimum practical irrigation often more than refills the effective root zone with water. This results in loss by deep percolation and decreases efficiency where a nitrate source

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Fertilizer equipment for banding cheap ammonia gas is useable on the same tractor used to apply dry materials (University of Arizona, Tucson).

EDWARD T. BRADFORD

The Handicapped Are Teamworkers

Edward T. Bradford suffered a mishap on his ninth working day after graduating from college which made a desk engineer out of him, but it didn't keep him from becoming a successful one.

When "Brad" got his civil and irrigation engineering degree from Colorado State University in 1934, his whole bent was toward construction work—an outdoorsman and athlete, he wanted to spend as much of his life as possible in the open air. Accordingly, he was happy to report on June 23 to the General Land Office (now Bureau of Land Management) for duty as a cadastral survey chainman.

On July 5, on Tennessee Pass in Colorado, the 500-pound rock on which Brad was standing gave way, tumbling him to the bottom of a 30-foot highway cut and thudding down on top of him. His left leg was crushed.

The injured man lay virtually unattended for hours in a mountain hospital. Gas gangrene set in. The fateful decision was automatic: amputate above the knee or die.

Brad returned to duty 6 months later, and in October 1935 became a draftsman for the Bureau of Reclamation. He rose through the engineering ranks to become Head of the Design Unit in the Kansas River Projects Office in 1947, and in 1955, to Chief of the Design Branch in the Region 7 Office, his present position.

Mr. Bradford would still rather be a construction engineer. But as a wise realist, he has adapted and developed his abilities with considerable success in the design field. Except for the change of direction in his career, and necessary denial of sports activities, his artificial leg lets him live a completely normal life.

JAMES C. NELSON

When James C. Nelson of Greeley, Colorado, volunteered for the Royal Air Force in 1940, he fully realized the risks he was courageously inviting. As courageously, he bears up under the injuries that resulted from his war service and that bother him to this day, without, however, letting them influence the quality of his work as auditor for the Northern Colorado Water Conservancy District at Loveland.

Squadron Leader Nelson crashed on takeoff while test flying a Mosquito bomber in 1944. He

The 15th National Employ the Physically Handicapped Week has been designated as October 4–10 by President Dwight D. Eisenhower. This is the 15th year in which the "Week," which only emphasizes the problem, has been observed. The President in his proclamation stated partially: " * * The expanding national program to develop maximum employment opportunities for the physically handicapped is continuing to attract the interest of additional thousands of dedicated volunteers in national, State, and community committees who are working wholeheartedly with public and private agencies for the rehabilitation and employment of handicapped persons * * *" This is an account of a few persons working in the Reclamation area.*

JAMES G. NELSON

lost his right leg below the knee and suffered a compound fracture of the left ankle. The lower portion of the left tibia was shattered and could not be set properly.

In spite of the injuries, Jim continued a career of flying after his discharge from the Royal Air Force. For 4 years he was chief demonstration pilot for a London aircraft firm, and for the 6 years following he served as senior experimental test pilot for an English company doing development work on supersonic delta-wing bombers.

He returned to the United States in 1953 and accepted the position he now holds. He lives in Loveland, Colo., with his English-born wife and two sons and a daughter aged 13, 14, and 15. He takes part in many community affairs and enjoys numerous sports. He indulges his enthusiasm for skiing every chance he gets despite the artificial leg and a stiff ankle. He is fond also of swimming.

The damage to his left ankle continues to trouble him, but he has overcome all the difficulties arising from loss of the right leg.

MELVIN M. SHYROCK AND DENVER B. GIMLIN

Two employees of the South Platte River District Office engage in responsible electrical operation work without being impaired by physical disabilities—Melvin M. Shyrock who is a power system dispatcher at Loveland, Colo., and Denver B. Gimlin, pumping plant operator at the Granby Pumping Plant near Granby, Colo.

Melvin Shyrock has a severe congenital deformation of the left forearm and hand. He was a War Department line electrician before entering the Bureau of Reclamation in March 1946 as a third-class lineman. He has served the Colorado-Big Thompson project diligently and efficiently as a lineman, maintenance electrician, construction electrician, powerplant operator, and substation operator at various locations. He has held his present position for 2 years.

With his wife and two children, 4 and 9 years old, he enjoys many activities. Fishing and camping are tops on his list of extra-curricular activities. He is a fine baseball pitcher and batter.

Denver G. Gimlin wears an artificial limb for his right leg below the knee, amputated after an accident in 1940 suffered while he was working on a high-voltage transmission pole for a utility in

MELVIN M. SHYROCK

eastern Colorado.

He entered the Bureau in 1951. In his maintenance work, he moves about without impairment doing a wide variety of tasks in switchyards and with electric motors, generators, pumps and convertors and electronic equipment switchboards. He formerly was an ardent golfer, and continues to swim at every opportunity.

JOHN R. GRIM

John R. Grim is serving as a general supply clerk in the Sacramento Valley Canals Project Office, Central Valley Project, Red Bluff, Calif. He is a veteran of World War II, having enlisted in the Navy in 1942, and served until September 1944. Grim lost his right leg, with severance above the knee, in a train accident at the Ship Docks in San Francisco, Calif., in September of 1943. Disability was rated at 85 percent. He wears an artificial limb.

Following his discharge from the Navy in 1944,

DENVER B. GIMLIN

Grim worked for a few months in a sugar factory at Crocket, Calif., but his health could not stand the intense heat. He next worked as a cab driver, despite his handicap, and was obliged to find another job when his company sold out and was taken over by another firm with its own drivers.

He returned to South Dakota to visit relatives and to look for work. Early in 1948, upon hearing of Bureau of Reclamation project openings in that State, under developments proposed by the Missouri River Basin Project, he applied for a job at Faith, S. Dak., where hiring was taking place to staff a construction office for a proposed reclamation dam in the locality. Grim was interviewed and subsequently hired as a clerk-typist and went to work for the Bureau on February 3, 1948.

His adjustment to his handicap and his determination not to let his disability interfere with

JOHN R. GRIM

his work have made him not only a capable and enthusiastic employee but also one who merited advancement. He received various assignments through the period of years, including tool checker, procurement agent, truck driver, caterpillar tractor and traction swing-crane operator, caretaker of Government construction-camp houses, recorder of weather readings, and checker of river water samples, storekeeper of power operation and maintenance stores at the Pierre, S. Dak., and presently general supply clerk in the Red Bluff, Calif. construction office.

John Grim is now 36 years of age. He was married in April of 1944. The Grims have three children, Bobby 14 years old, Nancy 11 years old, and Craig 4 years old.

PAUL CULLEY

To those familiar with classifications, the job descriptions of rigger and plant mechanic bring to mind hazardous occupation wherein the knowledge required for moving heavy equipment is basic. The work calls for physical stamina, agility, and the dexterity to meet, and overcome obstacles which are found to be inherent in this type of position. Paul Culley meets the requirements in the rigger and plant mechanic positions even though he carries with him a memento of his war service in World War II.

While serving as sergeant in the 345th Infantry Regiment, 87th Division, Third Army, and following campaigns in Rhineland and the Ardennes, Culley was wounded in action on March 4, 1945, while on the front lines near Nuestein, Germany. An exploding land mine caused him to suffer multiple wounds of the right leg, compound fracture and complete paralysis of the deep peroneal nerve, (drop foot, which necessitates the wearing of a spring steel brace attached to his right leg). Hospitalized from March 5, 1945, to October 4, 1946, and later going through a period of extended leave and adjustment, becoming familiar with the use of prosthesis, Culley eventually returned to his work at Hoover Dam. Paul does not have much to say about the days immediately following his return to work at Hoover Dam, and although he did not complain, we suspect that it was then that he was fighting the hardest fought battle of his life. Suffice to say that he won that battle, and today he remains in the forefront of those workmen who consistently win the praises of their supervisors.

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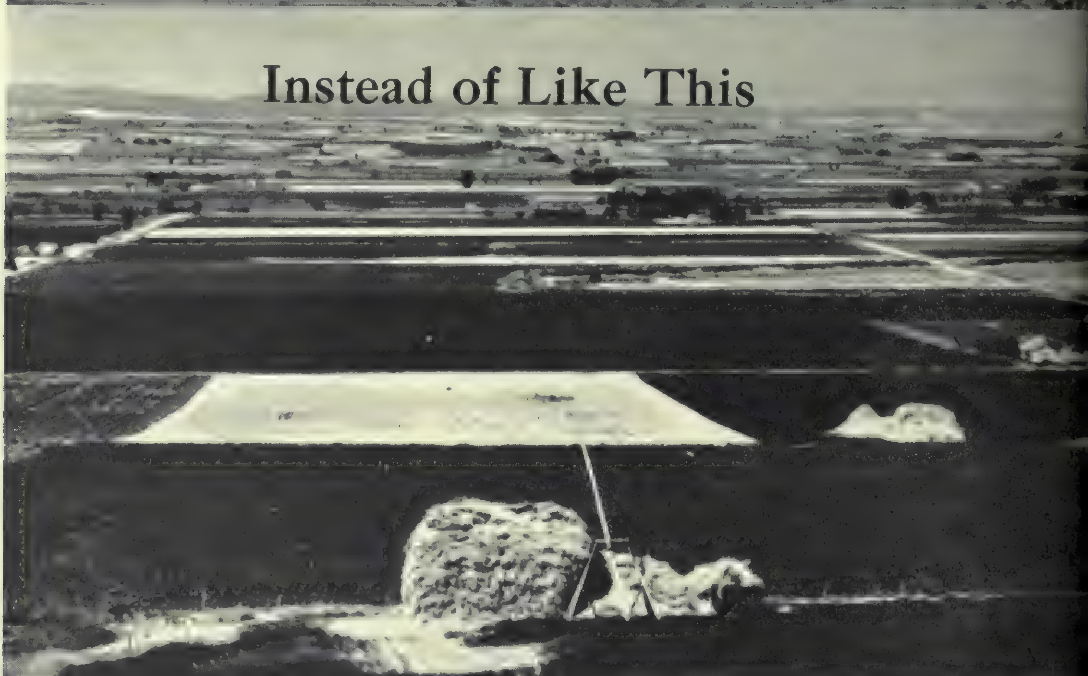

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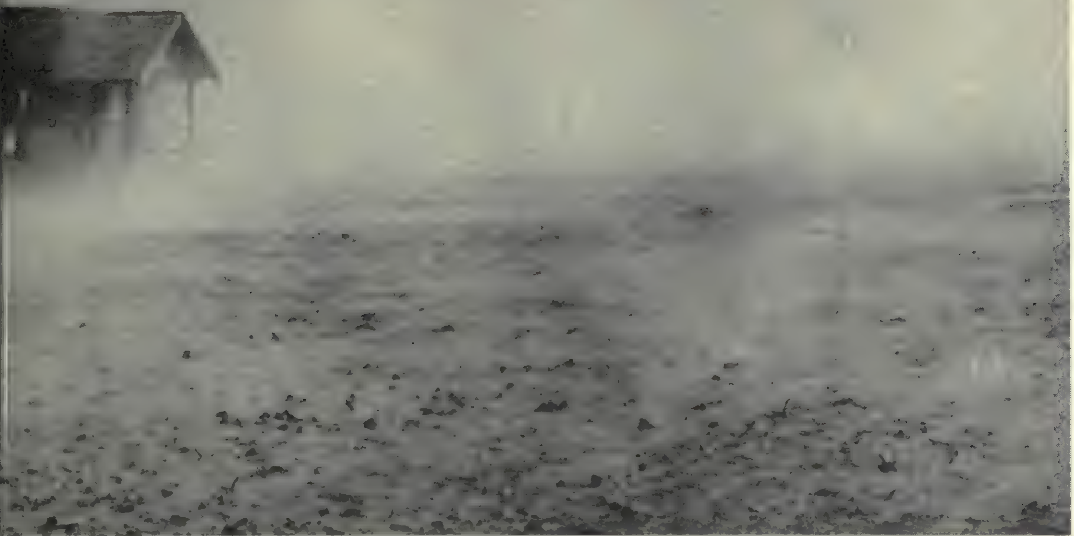
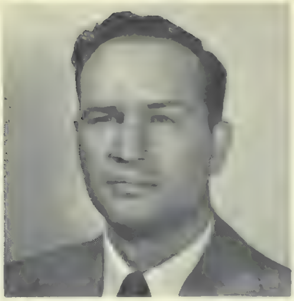


BERNARD P. BELLPORT



H. P. DUGAN

EDWIN F. SULLIVAN

KEY CHANGES IN BUREAU OFFICES

COMMISSIONER FLOYD E. DOMINY recently announced several key appointments in the Reclamation headquarters at Washington, D.C., the Denver, Colo.; Sacramento, Calif.; Boise, Idaho; and Amarillo, Tex., offices.

The new appointments are as follows: Associate Chief Engineer, Barnard P. Bellport, Regional Director, at Sacramento, Calif., Hugh P. Dugan; Assistant Regional Director, Sacramento, Calif., Edwin F. Sullivan; Regional Director at Denver, Colo., John N. Spencer; Assistant Regional Director, Denver, Colo., James L. Ogilvie; and Assistant Regional Director, Boise, Idaho, M. Boyd Austin.

Other changes include the appointments of Assistant Regional Director, John C. Thompson, at Amarillo, Tex.; and Donald R. Burnett, Chief of the Division of Project Development; Daniel V. McCarthy, Assistant Chief of the Division of Project Development; Gilbert G. Stamm, Chief of the Division of Irrigation and Land Use; Fred W. Gilbert, Chief, Division of Property Management; and F. W. Jones, Chief, Division of Organization and Personnel, all in the Washington, D.C., office.

"BERNARD P. 'BARNEY' BELLPORT—a veteran of 23 years with Reclamation—is eminently qualified for his new job by reason of his diversified construction experience, outstanding engineering competence, and managerial ability," said Commissioner Dominy at the time of his appointment. Mr. Dominy continued—"next in line to the vitally important job of Chief Engineer of one of the world's leading engineering centers, he is unusually well qualified for the position and the Bureau is fortunate to have him."

Mr. Bellport has been Regional Director at Sacramento since September 1957. A 52-year-old native of LaCrosse, Kans., he holds a B.S. degree in mining engineering, and has been with the Bureau of Reclamation since 1936. His entire Bureau career has been devoted to work in the Central Valley of California. In 1952 he became construction engineer in charge of the Solano Project which is also located in the Central Valley. He received a superior accomplishment award in 1951 for his work on the Central Valley Project. His earlier experience included work for mining companies, a utility company, and the Montana Highway Commission.

H. P. DUGAN "PAT," following his graduation in 1936 from Colorado State University, Fort Collins, Colo., with a bachelor of science degree in civil engineering and irrigation, entered Federal service with the U.S. Soil Conservation Service at Colorado Springs, Colo. After a period of a few months as an engineer-trainee for this organization, he transferred to the Bureau of Reclamation.

From September 1936 to September 1942 he was employed as an engineer on the investigation of potential irrigation projects at Yampa, Colo.; Yuma, Ariz.; La Grande, Oreg.; Pinedale and Green River, Wyo., and Denver, Colo. His experience during this period covered all phases of the investigations of water resource development projects.

Upon his return to the Bureau of Reclamation in January 1946, after the war, he was assigned to the Hydrology Branch of the Project Investigations Division. In September 1946 he was appointed as Head, Water Resources and Utilization Section of the Hydrology Branch, with technical responsibility for the adequacy of the hydrologic studies being made for potential projects in the 17 Western States. In August 1952 Dugan became Head of the River Regulation Section and was responsible for sponsoring and coordinating the hydrologic aspects of the Bureau of Reclamation in planning its river regulation function. In January 1954 he was appointed Assistant Chief Development Engineer of the Project Investigations Division—the position from which he was promoted to Regional Director.

He has prepared and participated in the preparation of reports and studies on innumerable proposed potential water resource development projects throughout the West and has been called upon to advise on potential developments and water resources in many parts of the world.

Dugan is a registered professional engineer in the State of Colorado.

EDWIN F. SULLIVAN, a civil engineer, has had 20 years experience on the Central Valley Project.

The region comprises the Central Valley of California, some contiguous coastal areas and the Klamath River Basin of northern California and southern Oregon.

Sullivan, who has been Chief of the Bureau's Fresno, Calif., office as supervisory general engineer, succeeds A. N. Murray who resigned recently to become general manager and chief engineer of the California State Reclamation Board. Sullivan will be assistant to Hugh P. Dugan, who was named regional director effective September 1 when Bernard P. Bellport moved to Denver, Colo., as associate chief engineer at the Bureau of Reclamation Engineering Center.

Sullivan is a native of Red Bluff, Calif., received a bachelor of science degree in engineering from the California Institute of Technology in 1939, and went to work

JOHN N. SPENCER

JOHN C. THOMPSON

DONALD R. BURNETT

GILBERT G. STAMM

for the Bureau of Reclamation in December of the same year.

He first worked in the Central Valley Project offices at Sacramento on investigations and planning for the development of the giant project. He went to Fresno in 1951 and has headed the field office there since 1954.

Sullivan is a registered civil engineer in California, a fellow of the American Society of Civil Engineers and a member of the California Society of Professional Engineers and the American Geophysical Union.

JOHN NEWELL SPENCER, Acting Director of Region 7 at Denver, is a career Government employee in the fields of land and water conservation. His Federal service began in November 1933 in the office of the Secretary of Agriculture, continued for 9 years in other agricultural work, commencing with the Bureau of Reclamation in December 1945. He is a dedicated conservationist, whose free-time activities are consonant with his background and present assignments.

During the entire period of his Bureau of Reclamation service prior to his appointment as Regional Director, Spencer was Supervisor of Irrigation in the Denver Regional Office.

Promotion of Spencer to the topmost regional position was due in part to the improvement of irrigation systems on existing projects and progress of new irrigation development in Region 7 during his tenure as Supervisor of Irrigation. During this period, 157,400 acres in portions of Colorado, Wyoming, Nebraska, and Kansas have been brought under irrigation and supplemental water has been brought to 759,400 acres.

Spencer was born in Hayden, Colo., and received his bachelor of science degree from Colorado State University.

He is a member of the American Society of Agricultural Engineers, American Association for Advancement of Science, and Wilderness Society.

JOHN C. THOMPSON fills the position vacated by Donald R. Burnett who transferred to the Bureau's office in Washington, D.C. to head the Div. of Project Development.

Thompson comes from Albuquerque, N. Mex., where he has managed the Middle Rio Grande Project for the Bureau of Reclamation since 1951, having been with the Bureau since 1935.

He is a native of Jackson, Miss. He attended the University of Mississippi and was graduated from the University of New Mexico in 1931 with a degree in civil engineering. His first position with the Bureau of Reclamation was as the Office Engineer on the Marshall Ford Dam in Texas. Subsequently, he spent 8 years on planning major irrigation, drainage, and dam projects, including the Bridge Canyon Dam and powerplant in Arizona and the Valley Gravity Canal on the Lower Rio Grande in Texas.

In 1949 Thompson was appointed special assistant to the Regional Director as the representative of the Bureau of Reclamation on the Interior Department's Southwest Field Committee, and in 1951 was selected to head the Middle Rio Grande Project, N. Mex.

Region 5 of the Bureau of Reclamation includes the States of Texas, New Mexico, and Oklahoma, and parts of Colorado and Kansas. The Gulf Basins Project, extending along the Gulf coast in Texas, now being investigated by Region 5 engineers, is one of the largest in the Bureau's history of developments accomplished in the 17 Western States in which it is authorized to operate. Another Bureau project with which Texas, and especially Amarillo, is concerned is the Canadian River Project which would supply the Texas Panhandle with much of its water needs.

DONALD R. BURNETT was named Chief of the Division of Project Development on July 19 and previously had been Assistant Director of Region 5 of the Bureau with headquarters in Amarillo, Tex. The Division is responsible for the advance investigation and planning of Reclamation projects.

He is a native of Madison, S. Dak., and attended the engineering schools of the University of Nebraska and Utah, graduating from the latter in 1931 with a B.S. degree in engineering. He has been with the Bureau of Reclamation since 1934, with the exception of war service with the Air Force as an ordnance officer.

GILBERT G. STAMM was Assistant Director of Region 1 of the Bureau with headquarters at Boise, Idaho. He has had about 24 years of Federal service, over 13 of which have been with the Bureau of Reclamation. A native of Denver, Colo., he is a graduate of Colorado State University with a B.S. degree in agricultural economics. His first 10 years of Federal service, almost all of which was related to irrigation research and development, operation and maintenance, were spent with various agencies of the U.S. Department of Agriculture (covering 17 Western States).

He was formerly superintendent of Reclamation's Central Snake River Projects in southwestern Idaho and eastern Oregon and regional supervisor for irrigation of the Pacific Northwest. # # #

CANAL SAFETY BOOKLET

A new booklet, Canal Safety, has been published by the Bureau of Reclamation as an additional measure to protect the public, operating personnel, and animal life from the hazards of canals and other water-carrying structures.

Copies of the booklet may be obtained by writing to any Bureau of Reclamation field office. Regional offices are located in Boise, Idaho; Sacramento, Calif.; Boulder City, Nev.; Salt Lake City, Utah; Amarillo, Tex.; Billings, Mont. and Denver, Colo.

THE 10 COMMANDMENTS OF SAFETY

1. Treat every gun with the respect due a loaded gun. This is the first rule of safety.

2. Guns carried into camp or home, or when otherwise not in use, must always be unloaded, and taken down or have actions open; guns always should be carried in cases to the shooting area.

3. Always be sure barrel and action are clear of obstructions, and that you have only ammunition of the proper size for the gun you are carrying. Remove oil and grease from chamber before firing.

4. Always carry your gun so that you can control the direction of the muzzle, even if you stumble; keep the safety on until you are ready to shoot.

5. Be sure of your target before you pull the trigger, know the identifying features of the game you intend to hunt.

6. Never point a gun at anything you do not want to shoot; avoid all horseplay while handling a gun.

7. Unattended guns should be unloaded; guns and ammunition should be stored separately beyond reach of children and careless adults.

8. Never climb a tree or fence or jump a ditch with a loaded gun; never pull a gun toward you by the muzzle.

9. Never shoot a bullet at a flat, hard surface or the surface of water; when at target practice, be sure your backstop is adequate.

10. Avoid alcoholic drinks before or during shooting. #

Reprinted from a leaflet supplied free in quantities to anyone interested in advancing the cause of hunting and shooting safety. Send requests to Sportsmen's Service Bureau, 250 East 43d Street, New York 17, N.Y.

CARR HEADS WATER COMMISSION FOR CALIFORNIA

JAMES K. CARR, former official of the Bureau of Reclamation both in California and Washington, D.C., has been elected chairman of the California Water Commission.

The Commission is an advisory agency on water development policy and also has responsibilities in water rights administration and Federal appropriations of interest to California.

Mr. Carr is a registered civil engineer in California and Washington, D.C., and is a graduate of Santa Clara University. He was assistant to the Regional Director in the Bureau's Sacramento, Calif., office for several years, later moving to District Manager of the Sacramento Valley District in Region 2. In 1952 he was transferred to the Washington office, and later became engineering consultant to the House Interior Committee.

He has been assistant General Manager of the Sacramento, Calif., Municipal Utility District since 1953.

Mr. Carr has been closely identified with the Central Valley Project for many years, having worked on construction of Shasta Dam as a young engineer just graduated from Santa Clara University.

CLINTON REPORTS

Region 6 Director F. M. Clinton, who attended the 26th Executive Committee Meeting of the International Commission on Large Dams in Helsinki, Finland, recently and then toured water projects in Finland and Sweden stopped in Washington en route home.

Mr. Clinton was impressed with the igenuity of the Finns and Swedes in using locally available materials (such as evenly hewed logs) in form work and support. (The logs, incidentally, are floated downstream to pulp mills after use in construction.) The Scandinavians also lean heavily toward rockfill dams, he said. They employ deep tailrace excavation to gain head at their underground powerplants, as being more economical than raising the height of their dams. In addition, they balance tunnel and powerplant excavation with rock requirement for dam construction. The Finns have a 400-kilovolt transmission system—and the Swedes a 380-kv.—as compared with the Bureau's highest voltage of 220 kv.

Water Report

WATER SUPPLIES WERE ADEQUATE for most irrigated areas of the North Pacific and northern Rocky Mountain states. With streamflows among the minimum of record, WATER for irrigation WAS SHORT over a wide area of the Southwest and especially in the southern half of California.

Snowmelt season streamflow was above normal in only a few isolated areas, mostly on Columbia River tributaries in western Montana. The adequate water supplies of 1959 were possible only through depletion of reservoir storage carried over from the good water years of 1957 and 1958. Irrigated lands with no carryover storage suffered some shortages this year, almost without exception.

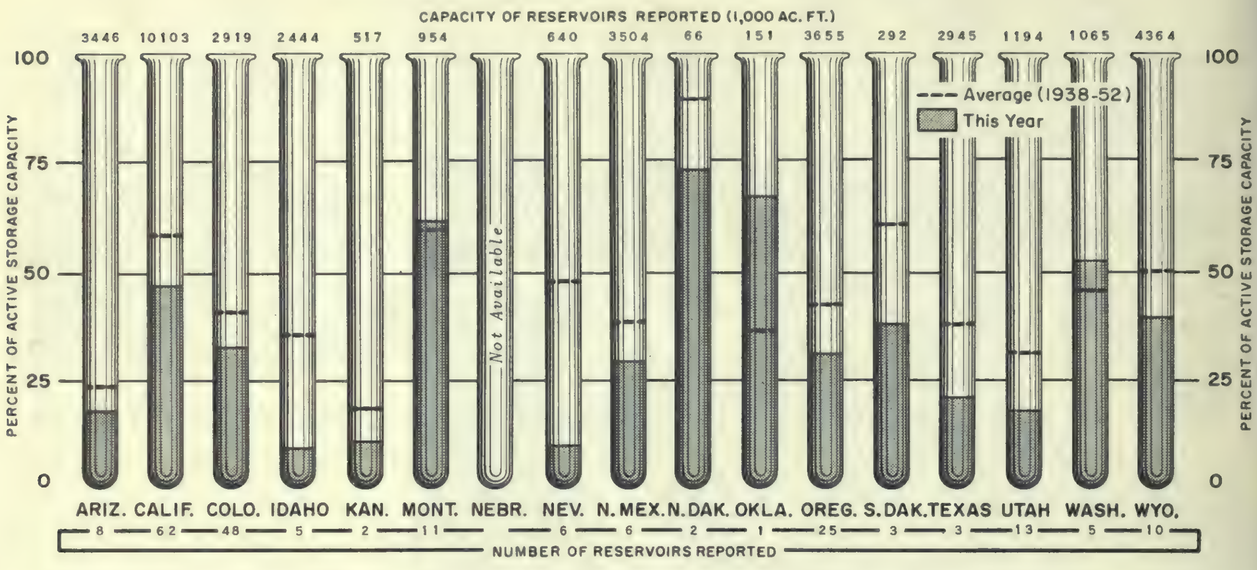
With storage depleted, the snowpack during the winter of 1959–60 will have to be normal or better to provide a good water supply next year. Although the depletion of reservoirs is not as severe as at the end of the 1953–56 drouth period, the stored water is no longer available as a reserve, as was the situation for the past two water years.

The summer of 1959 was dry, but freakish September weather has already given some boost to the prospects for 1960. Heavy rainfall was gen-

The Soil Conservation Service coordinates snow surveys during the winter and spring months conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal agencies, various departments of the several states, irrigation districts, power companies, and others. The California Department of Water Resources, which conducts snow surveys in that state, contributed information on California water supply as a part of this report. The Water Rights Branch, British Columbia, Department of Lands and Forests has charge of the snow surveys in that province.

by HOMER J. STOCKWELL, Water Supply Forecast Section, Snow Survey Supervisor, Soil Conservation Service, Portland, Oreg., and Gregory L. Pearson, Snow Survey Supervisor, Soil Conservation Service, Salt Lake City, Utah

Reservoir Storage on October 1, 1959



eral over all western states the past three weeks with an extremely unseasonal snowfall in Colorado and areas of states adjoining. Dry mountain soils have become wet. This will reduce the amount of water required from any given snowpack to wet up the soils, making more available for runoff.

Summer flows of the major streams are indicated by only incomplete provisional records, but the flow of major streams was approximately as follows in percent of normal: Colorado at Grand Canyon, 65 percent; Rio Grande at Otowi Bridge, 35 percent; Columbia at The Dalles, 115 percent; Missouri at Fort Benton, 85 percent; and the Sacramento at Red Bluff, 70 percent.

This article is prepared for RECLAMATION ERA from information supplied by the Snow Survey and Water Supply Forecast Section, Soil Conservation Service, United States Department of Agriculture.

Water supplies for Washington, western Montana and northern Idaho were good. The season ended with some improvement in reservoir storage over a year ago. The flow of the Flathead River was 150 percent of normal. The flow of all streams in Wyoming was below normal. Reservoirs were drawn down to meet irrigation water demands. The North Platte project now has a relatively small amount of water in storage. Eastern Colorado had adequate supplies at the expense of carryover storage. All of the carryover water in John Martin Reservoir was used.

In the Colorado River basin, runoff was much lower than expected. Summer precipitation was extremely deficient.

An extremely low runoff occurred in the Rio Grande. Water supply was supplemented by pumps in Colorado. Below Elephant Butte over a half million acre-feet of stored water was used for top crop production. The Tucumcari and Carlsbad projects in eastern New Mexico had a good season using carryover storage and with summer rains. These projects have a good carryover for next year.

A combination of an extremely low April 1 snowpack and a dry summer resulted in a widespread water shortage over Arizona, Nevada, the southern half of Utah and California, and extending into central Oregon. On streams without carryover storage water supplies were very poor. California reports streamflow the fourth or fifth lowest of record. All streamflow was less than 50 percent of normal, except in one Salt River tributary in Arizona. In the Salt River Valley late summer rains and carryover storage provided a near normal surface water supply.

Reservoirs in California were depleted, but with a normal spring runoff they can be expected to have the usual amount in storage at the beginning of next summer.

In Oregon, southern Idaho and central Utah the adequacy of water supply was directly related to the availability of storage. Irrigated

areas along streams without storage had a poor year.

As compared to a year ago, storage is seriously depleted but mountain and valley soil moisture is much improved over October 1, 1958. The importance of having adequate reservoir storage on tributary streams was demonstrated this year in areas where direct streamflow was short.

A heavy snowpack will be necessary this next winter if we are to have a good year in 1960.

In the following paragraphs 1959 water conditions by states are briefly reviewed, with a summary of conditions affecting the 1960 water supply as of October 1, 1959.

This report was prepared under the supervision of *R. A. WORK*, Head, Water Supply Forecasting Section, Soil Conservation Service, Portland, Oregon, from data and reports from agencies mentioned above, and from snow survey supervisors of the Soil Conservation Service: Arizona, George Watt; Colorado and New Mexico, Jack N. Washichek; Idaho and Columbia Basin, M. W. Nelson; Montana and Missouri Basin, A. R. Codd; Nevada, Manes Barton; Oregon, W. T. Frost; Utah and Colorado Basin, Gregory L. Pearson; Washington, Robert T. Davis; Wyoming, George W. Peak.

ARIZONA—Following the very poor winter and spring runoff, irrigation supplies for 1959 depended on well water and carryover storage supplies from the previous year. In almost all cases there was adequate water available for this year's crops. Good July and August precipitation also added to the irrigation supply, along with replenishing the stock water supply and improving forage on the range. However, storage is low and another dry season such as last winter will cause a serious water shortage for next year in many areas.

BRITISH COLUMBIA—The Department of Lands and Forests of British Columbia reports that spring and summer water supply has been excellent during 1959. Generally streamflows were close to average in April and May and above average in June, July, August and September, with the exception of the Okanagan region. April through September accumulated precipitation was above normal. In the Okanagan Valley, meteorological stations recorded normal to below normal rainfall.

Runoff from mountain snow was greater than usual in June and July with well above normal rainfall in August

Continued on page 111

Water stored in western reservoirs

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Aug. 31, 1958	Aug. 31, 1959
Region 1	Baker	Thief Valley	17, 400	6, 400	9, 500
	Bitter Root	Lake Como	34, 800	6, 500	12, 000
	Boise	Anderson Ranch	423, 200	313, 300	341, 900
		Arrowrock	286, 600	21, 500	5, 800
		Cascade	654, 100	466, 000	488, 400
		Deadwood	161, 900	107, 600	49, 800
		Lake Lowell	169, 000	67, 600	32, 000
		Lucky Peak	278, 200	261, 400	187, 500
	Burnt River	Unity	25, 200	10, 600	4, 400
	Columbia Basin	F. D. Roosevelt Lake	5, 072, 000	5, 225, 000	5, 225, 000
		Banks Lake	761, 800	759, 100	625, 700
		Potholes	470, 000	102, 100	135, 000
	Deschutes	Crane Prairie	55, 300	31, 000	20, 000
		Wickiup	187, 300	89, 000	29, 000
	Hungry Horse	Hungry Horse	2, 982, 000	2, 978, 800	3, 004, 600
	Minidoka	American Falls	1, 700, 000	404, 500	112, 500
		Grassy Lake	15, 200	9, 200	6, 300
		Island Park	127, 200	39, 500	38, 600
		Jackson Lake	847, 000	635, 700	641, 700
		Lake Walcott	95, 200	90, 900	83, 400
	Ochoco	Ochoco	47, 500	(1)	4, 800
	Okanogan	Conconully	13, 000	6, 700	7, 100
		Salmon Lake	10, 500	10, 300	10, 300
	Owyhee	Owyhee	715, 000	505, 200	191, 700
	Palisades	Palisades	1, 202, 000	548, 600	686, 900
	Umatilla	Cold Springs	50, 000	6, 500	6, 900
		McKay	73, 800	14, 900	12, 900
	Vale	Agency Valley	60, 000	22, 800	10, 400
		Warm Springs	191, 000	118, 000	24, 600
	Yakima	Bumping Lake	33, 700	13, 400	12, 700
		Clear Creek	5, 300	5, 300	5, 300
		Cle Elum	436, 900	128, 900	249, 600
		Kachess	239, 000	139, 000	173, 100
		Keechelus	157, 800	35, 600	94, 300
		Tieton	198, 000	62, 100	104, 900
Region 2	Cachuma	Cachuma	201, 800	196, 000	186, 800
	Central Valley	Folsom [2]	920, 300	621, 500	284, 200
		Jenkinson Lake	40, 600	34, 200	29, 200
		Keswick	20, 000	18, 000	19, 800
		Lake Natoma	8, 800	8, 700	8, 500
		Millerton Lake	427, 800	145, 300	59, 100
		Shasta Lake	3, 998, 000	3, 282, 600	2, 157, 300
		Lake Thomas A. Edison	125, 100	119, 200	74, 700
	Klamath	Clear Lake	513, 300	338, 500	186, 100
		Gerber	94, 300	54, 900	8, 900
		Upper Klamath Lake	524, 800	394, 100	189, 600
	Orland	East Park	50, 600	35, 000	1, 600
		Stony Gorge	50, 000	20, 100	24, 200

Continued on P. 110

PAUL CULLEY

HANDICAPPED

Continued from Page 97

Paul, who lives in Las Vegas, Nev., is very active in civic affairs. He has served as deputy coroner of Las Vegas, is a member of the Clark County School Board, the draft board, adviser to the Nevada State Welfare Board, Director of the Veteran's Coordinating Council, past Vice President of the Nevada State Federation of Labor, officer in the Stationary Engineer's Union (Local 54), member of the Central Labor Council and Building Construction Trades Council, past Commander of the Veterans of Foreign Wars, and he absent-mindedly admits to being a member of the Disabled American Veterans. # # #

Concrete for Glen Canyon Dam

The magnitude of the concrete production and placement program at Glen Canyon Dam and Powerplant, Colorado River Storage Project major features in northern Arizona, requires an unusually large and complex construction plant. Approximately 5 million cubic yards of concrete will be produced and placed in the dam and powerplant. Concrete processing for these structures is scheduled to start in November of this year.

Concrete placement is tentatively scheduled at the rate of approximately 9,000 cubic yards per day. To achieve this goal, the contractor will employ a mix plant having six 4-cubic yard tilting mixers. The plant will have a 3,000-ton aggregate storage bin divided into eight compartments. Mixers will discharge into compartmented hoppers totaling 28-cubic yard capacity. The hoppers in turn will discharge into 12-cubic yard capacity railroad transfer cars which will deliver the concrete to 12-cubic yard buckets at either of two 50-ton capacity cableways for depositing in the dam. The 12-cubic yard buckets are the largest buckets to be used on a Bureau of Reclamation construction undertaking.

The cableways will be situated so that one can pass above the other; both will have traveling head and tail towers and either line will be able to service all areas of the dam and powerplant. Working together, the two cableways will be able to handle a 100-ton load. The upper, main cableway spans 2,050 feet between towers on opposite sides of Glen Canyon. The line, largest ever built, is 4 inches in diameter, weighs 38 pounds per foot, has a strength of 880 tons, and will operate at a tension of 320 tons.

A concrete aggregate processing plant, including heavy media processing features, will be installed at the lower end of the Wahweap Creek aggregate deposit about 6 miles northwest of the damsite. At Clarksdale, Ariz., a new cement mill is being constructed to supply about 3 million barrels of cement. A plant for processing some 1,170,000 barrels of natural pozzolanic materials is being erected north of Flagstaff.

* * *

Cement and pozzolan for the dam will be furnished by the Government on contracts, separate from the prime construction contract. Commercial sources of pozzolan located several hundred miles distant and material deposits in the general vicinity of the dam were investigated. Altogether some 97 samples from 74 sources (9 from commercial sources) including volcanic materials, shales and clays, diatomite and diatomaceous earth, and fly ash were tested. Approximately 3 million barrels of portland cement at an estimated peak rate of production of 120,000 barrels per month will be required to build the dam. Because of the long haul from the nearest existing cement plant, and the large quantity of cement required, it was indicated that some savings might be realized by constructing a plant nearer the damsite.

A helicopter is ideal for applying low-volume chemical sprays on phreatophyte growth along irrigation and drain canals, especially where there are no ditchbank roads (Bureau of Reclamation Region 6).

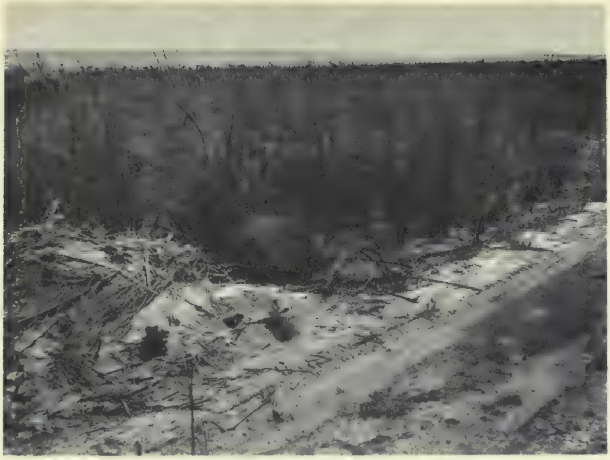
PHREATOPHYTES

Continued from Page 88

4 pounds in high volume of water applied by ground-spray equipment. On the other hand, low-volume sprays applied by airplane have consistently failed to give more than a temporary kill of salt cedar topgrowth, even when repeated as many as four to five times during periods of 3 to 5 years. This conclusion is based upon 4 small-scale airplane test applications in Arizona and 20 medium-to-large scale airplane applications in New Mexico by the Bureau of Reclamation and New Mexico State Engineer's Office from 1948 through 1956. A total of 51,746 acres was airplane-sprayed on the Pecos River and Rio Grande flood plains at an average cost of $3.18 per acre. Some of this acreage included areas resprayed two to five times. These spray treatments gave good kills of topgrowth and temporarily reduced the nonbeneficial consumptive use of water but with one exception, gave very little permanent reduction in the stand of salt cedar. Because of the hazard to cotton, no airplane applications of 2,4-D are made on that crop during its growing season. The spraying of the 10,000 acres of floodway along the Rio Grande is being done with a ground-spraying unit consisting of a large-capacity centrifugal pump, a 1,750-gallon tank, and a 32-foot hydraulic boom on each side, mounted on a 4-wheel trailer equipped with trunnion axle and four 18- x 24-inch tires. Extension booms and boom-jet nozzles at the end of each boom provide for spraying a swath approximately 100 feet wide.

Research on Phreatophytes

Considerable research on water use by phreatophytes has been done in Southwestern States by the Geological Survey, the Agricultural Research Service, and the Soil Conservation Service. The ecology and physiology of salt cedar is being stud-



Two airplane-spray applications of 2,4-D killed 85 percent of the salt cedar in this 100-acre area. Airplane spraying of more than 51,000 acres of salt cedar in 18 other areas gave good kills of top-growth but low percentage plant kills (Bureau of Reclamation Region 5).

ied at Tempe, Ariz., by the U.S. Forest Service.

Research on control of phreatophytes has been limited mostly to a few experiments on control of willows in Utah, Montana, and Washington, and to a series of experiments on salt cedar near Phoenix, Ariz., by the Agricultural Research Service and the Bureau of Reclamation. Conclusions from this latter research begun in 1951 may be summarized as follows:

1. Clearing off mature salt cedar growth by mechanical methods and burning the crushed down debris followed by spraying regrowth when 4 to 6 months old with a 50–50 mixture of the esters of 2,4-D and 2,4,5-T at 3 pounds per acre or more is the most effective and least expensive method of control now known.

2. Recent research indicates that 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) is more effective than 2,4-D or 2,4,5-T but more research is needed on this question.

3. Rapid regrowth of salt cedar from crowns and roots after mechanical clearance and burning usually reached a maximum height of 6 to 8 feet the first growing season.

4. Single spray applications of 2,4-D or mixtures of 2,4-D and 2,4,5-T on mature salt cedar or regrowth following mechanical clearance usually cause defoliation and kill a high percentage of topgrowth but seldom will reduce the stand appreciably.

5. Ester forms of 2,4-D and 2,4,5-T alone or in mixture are much more effective than the amine of 2,4-D. Application rates of less than 2 pounds per acre usually give poor results.

6. Young salt cedar regrowth or seedlings (6 months or less) is much more easily killed by 2,4-D and mixtures of 2,4-D and 2,4,5-T than is growth a year or more old. A single spray application at 2 pounds or more per acre will kill young salt cedar seedlings. However, mature salt cedar or regrowth after mechanical clearance requires repeated applications, usually 3 or more, over a period of 2 or more years.

7. Dormant applications of 2,4-D and 2,4,5-T esters in oil or oil-water emulsion as basal or cut-stub treatments at concentrations of 0.5 percent or more are effective but expensive methods suitable only for small or widely scattered infestations of salt cedar.

A more effective chemical method than those now known is urgently needed for controlling the large-area infestations along rivers in the Southwest. Such an effective and inexpensive chemical treatment must not be hazardous to cotton, the region's most important cash crop. # # #

Bulldozing is the most common mechanical method of clearing off tall mature salt cedar and other phreatophyte growth. Usually the debris is bunched and burned and followup discing, mowing, or spraying with 2,4-D is used to maintain control of regrowth and seedlings (Bureau of Reclamation Region 3).

Your Magazine

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

"GET ACQUAINTED" COPIES

If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D.C. We shall be glad to send them copies of back issues.

COMMERCIAL FERTILIZERS

Continued from Page 94

is used. Also, fertilizer distribution and amount of intake, often is not uniform.

Fertilizer sprayed upon the foliage of growing plants may give fast response in plants with nutrient deficiencies or incipient deficiencies. However uptake of nutrients from foliage sprays is limited and depends upon crop, leaf maturity, relative humidity, temperature, source of material, and other factors. Also the nutrient source and concentration must not harm plant tissue appreciably. If the crop requires 100 pounds of nitrogen per acre, use of foliar sprays of either urea nitrogen or urea plus ammonium nitrate should require several applications and a large amount of cost and work. The best use for foliar sprays is probably in orchards where spraying equipment is available, where an incipient or actual shortage demands immediate attention, or as an experimental tool to control nutrient levels within plants.

There is no best method of application for all situations. Choice will depend upon crop, soil type and condition, fertilizer source and rate, cost, operator preference, type of application, etc. Biological response to various methods and rates of application is far more complex than commonly believed. Dr. C. T. DeWit, a skilled scientist in Holland, has given an extensive mathematical and comparative consideration of various methods and rates of application. Even though fertilizer placement is complex, and oversimplification is hazardous, it appears that broadcasting needed nutrients and incorporation into the soil is a "good bet" for general conditions until better information is available.

# # #

WATER
WHAT IS WATER WORTH?

Water is a commodity so precious that no tyrant has ever dared deny it to his people. The earliest records of our civilization are linked to the spring and the waterhole, the river, and the well. The Children of Israel faltered in the wasteland and were ready to revolt until Moses struck the rock and brought forth a spring.

Wars have been fought over water rights and once mighty nations have vanished because their water resources failed. Men have battled to the death over the last few drops in a canteen. Formidable fortresses, impregnable in other respects, have fallen because of an insufficient water supply.

Ships' masters have had to risk the destruction of their vessels and the slaughter of their crews because water shortages forced landings on savage isles. Families have given up their homes and deserted their properties because of failing wells and dried-up water courses. London was virtually destroyed by fire in the seventeenth century and Chicago reduced to ashes in 1871 because sufficient water could not be delivered to the right place at the right time.

What is water worth?

Water is beyond price—so far beyond price that water is free of all price.

Reprinted from What Price Water? by permission of American Water Works Assoc., Inc., New York 16, New York.

O. C. HEDGEPATH, North Unit, Deschutes Project, in Oregon, drilling his farm to ladino clover (*Photo by Stanley Rasmussen, formerly of Region 1*).

Continued from p. 105

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Aug. 31, 1958	Aug. 31, 1959
Region 3	Boulder Canyon	Lake Mead	27,207,000	23,814,000	20,617,000
	Parker-Davis	Havasu Lake	216,500	573,400	108,700
		Lake Mohave	1,809,800	1,511,700	1,388,700
	Salt River	Apache Lake	245,100	243,000	242,000
		Bartlett	179,500	54,000	39,000
		Canyon Lake	57,900	53,000	54,000
		Horseshoe	142,800	20,000	14,000
		Theodore Roosevelt Lake	1,381,600	396,000	223,000
		Sahuaro Lake	69,800	56,000	43,000
Region 4	Eden	Big Sandy	38,300	3,500	500
	Fruitgrowers Dam	Fruitgrowers	4,500	1,300	800
	Humboldt	Rye Patch	190,000	131,100	25,900
	Hyrum	Hyrum	15,300	4,700	3,700
	Mancos	Jackson Gulch	9,800	4,700	800
	Moon Lake	Midview	5,800	600	3,000
		Moon Lake	35,800	7,200	2,100
	Newlands	Lahontan	290,900	202,500	44,500
		Lake Tahoe	732,000	698,400	469,200
	Newton	Newton	5,400	900	400
	Ogden River	Pineview	110,200	21,300	9,100
	Pine River	Vallecito	126,300	62,400	30,400
	Provo River	Deer Creek	149,700	101,900	67,000
	Scofield	Scofield	65,800	39,700	13,700
	Strawberry Valley	Strawberry Valley	270,000	155,300	108,500
	Truckee Storage	Boca	40,900	11,700	1,000
	Uncompahgre	Taylor Park	106,200	75,200	61,700
	Weber River	Echo	73,900	8,200	15,700
Region 5	W. C. Austin	Altus	162,000	107,500	103,100
	Balmorhea	Lower Parks	6,500	2,000	200
	Carlsbad	Alamogordo	122,100	123,400	104,500
		Avalon	6,000	4,700	1,400
		McMillan	32,300	35,800	22,200
	Colorado River	Marshall Ford	1,837,100	608,000	724,700
	Middle Rio Grande	El Vado	194,500	128,100	20,200
	Rio Grande	Caballo	340,900	50,400	55,400
		Elephant Butte	2,185,400	975,900	575,300
	San Luis Valley	Platoro	60,000	34,000	4,000
	Tucumcari	Conchas [2]	467,300	274,000	245,500
	Vermejo	Reservoir No. 2	2,900	2,200	2,000
		Reservoir No. 13	5,000	4,700	3,200
		Stubblefield	16,100	12,000	6,400
Region 6	Missouri River	Angostura	92,000	73,700	20,000
		Boysen	710,000	475,600	211,800
		Canyon Ferry	1,615,000	1,387,000	1,516,400
		Dickinson	13,500	4,500	3,400
		Fort Randall [2]	4,900,000	1,534,000	2,394,900
		Garrison [2]	18,100,000	4,786,000	4,746,000
		Lake Taschida	218,700	63,500	55,300
		Jamestown	39,200	14,400	9,300
		Keyhole	190,300	0	500
		Lewis and Clark Lake [2]	385,000	332,100	247,700
		Pactola	55,000	18,300	20,900
		Shadehill	300,000	79,100	75,600
		Tiber	762,000	196,800	107,200
	Belle Fourche	Belle Fourche	185,200	34,000	1,500
	Fort Peck	Fort Peck [2]	14,839,000	4,655,100	6,446,400
	Milk River	Fresno	127,200	43,000	74,300
		Nelson	66,800	41,000	40,300
		Sherburne Lake	66,100	16,000	34,800
	Rapid Valley	Deerfield	15,100	9,700	3,300
	Riverton	Bull Lake	152,000	97,700	77,700
		Pilot Butte	31,600	6,900	5,200
	Shoshone	Buffalo Bill	380,300	152,400	294,500
	Sun River	Gibson	105,000	40,000	65,200
		Pishkun	30,100	25,500	25,800
		Willow Creek	32,400	29,500	6,200
Region 7	Colo.-Big Thompson	Carter Lake	108,900	25,400	41,800
		Granby	465,600	432,800	348,600
		Green Mountain	146,900	137,300	141,100
		Horsetooth	141,800	46,700	52,700
		Shadow Mountain	1,800	600	800
		Willow Creek	9,100	4,000	1,800
	Missouri River Basin	Bonny	167,200	34,700	33,300
		Cedar Bluff	363,200	178,500	174,100
		Enders	66,000	35,000	25,000
		Harlan County [2]	752,800	236,200	168,000
		Harry Strunk Lake	85,600	30,000	17,400
		Kirwin	304,800	80,600	71,500
		Swanson Lake	249,800	121,600	71,000
		Webster	257,400	84,100	61,700
	Kendrick	Alcova	24,500	27,900	26,800
		Seminole	957,000	928,300	591,400
	Mirage Flats	Box Butte	30,400	16,800	9,800
	North Platte	Guernsey	39,800	27,000	23,700
		Lake Alice	11,200	1,900	3,800
		Lake Minatare	59,200	29,800	9,500
		Pathfinder	1,010,900	900	129,300
Alaska Dist	Eklutna	Eklutna Lake	150,000	165,900	(1)

[1] Not reported. [2] Corps of Engineers Reservoir. [3] Includes some superstorage above active capacity.

WATER REPORT

Continued from P. 105

and September contributing to the high streamflows in these two months. Because of this above average fall precipitation watershed soils appear to be well primed so that a normal winter snowpack should provide British Columbia with a good water supply next year.

CALIFORNIA—The Department of Water Resources reports that the water year ending September 30, 1959, must be considered one of the driest of record with respect to conditions influencing the supply in California. The North Coastal area was the only significant part of the state receiving normal precipitation. Throughout the rest of the state precipitation averaged about 60 percent of normal, with the parched South Coastal area averaging less than 40 percent of normal.

Above normal spring temperatures produced early snowmelt, which caused peak flows on snowmelt streams to occur one to two months before such flows are normally expected. With this early melting and an already deficient early season snowpack, April 1 snow water content was ranked the lowest of record in most areas.

The major area of irrigation use in California is the Central Valley. The April-July runoff of major Central Valley streams was 6,625,000 acre-feet as compared to an average runoff of 13,719,000 acre-feet. The April-July runoff of Sacramento River at Red Bluff was the 10th lowest in 59 years of record, and about 70 percent of normal. However, the Sacramento River was the only snowmelt stream of the Central Valley area to exceed a 50 percent of normal April-July runoff. Runoff with respect to normal on other major streams in this area ranged from 10 percent for the Tule River near Porterville (4th lowest of record) to above 50 percent for the Feather River near Oroville (7th lowest of record).

In general, April-July runoffs of the remaining snowmelt streams in the Central Valley were the 4th lowest of record for streams south of latitude of Stockton, and the 5th lowest of record for streams between this latitude and the Feather River Basin.

On October 1, 1959, there were 5,949,000 acre-feet of water stored in the 43 major reservoirs serving the Central Valley. This was 2,851,000 acre-feet less than that of October 1, 1958, about 80 percent of the 10-year average, and 45 percent of the usable capacity.

Although reservoir storage at present is somewhat below average, normal spring runoff during the 1960 season would result in average storage amounts in almost all reservoirs in this area.

COLORADO—Streamflow throughout the state was somewhat less than expected this summer. Since carryover storage in most areas was normal or better, farmers having access to this supplemental supply had only limited shortages. Areas in the central and southern part of the state that depended on streamflow alone experienced more severe shortages.

To date, the Colorado Big-Thompson Project has supplied 211,000 acre-feet to water users along the South Platte. The John Martin Reservoir was emptied to supply enough water to mature crops on the Lower Arkansas in Colorado and Kansas. As was anticipated, shortages occurred in the southern part of the state. Pumping helped to supplement surface supplies.

Present reservoir storage is the lowest since 1956. Summer precipitation for the state as a whole was about 90 percent of normal.

An unseasonable snowstorm hit practically all of the state late in September and deposited up to 70 inches of snow at mountain elevations. Soil moisture in both mountains and valleys should be excellent. Prior to this storm, most areas were reporting poor to fair soil moisture.

Unless the coming snow season is better than normal, water shortages may exist in many parts of Colorado next summer.

IDAHO—The water supply forecast made on April 1 this year has proven to be slightly high in southern Idaho, where a poor water supply was forecast, and slightly low in northern Idaho, where an above average water supply was forecast.

In the irrigated areas of Idaho, reservoir storage on the main rivers made up for deficiencies in streamflow and a normal water supply was available. On the smaller streams, where there is inadequate storage facilities, the low water supply reduced crop production significantly. In general, farm and ranch operators, with low water supply outlook, were forewarned and made efficient use of the water supplies available.

The heavy rains throughout Idaho in the latter part of September have definitely broken the drought which has prevailed over the southern areas during last winter and this summer. Precipitation has brought soil moisture up to near normal for this time of the year. The continuation of the present weather trend will result in well primed soils for the 1960 season.

KANSAS—There was no material reduction in crops in irrigated areas along the Arkansas River. This was primarily due to the carryover storage in John Martin Reservoir in Colorado. Summer precipitation was about 80 percent of normal. With no carryover storage in John Martin, a high snowpack will be necessary to insure adequate water next year.

MONTANA—Irrigation water supplies for the 1959 growing season were generally adequate. Below normal spring temperatures resulted in a delayed runoff from mountain streams. Runoff from plains streams was low due to hot, dry weather with July being one of the driest on record. Precipitation in late September has greatly improved soil moisture conditions throughout the state.

The severe earthquake which rocked northwestern Montana in mid-August and created Quake Lake on the Madison River increased the flow of springs and streams in the Upper Madison, Gallatin and Red Rock river basins.

Storage in both irrigation and power reservoirs is above average.

Streamflow has been much above average on most of the Columbia River Basin with the South Fork of the Flathead River flowing about 150 percent of the 1938–52 average during the April-September period. With the exception of the plains streams, which have produced much below average runoff, streamflow of the Missouri River Basin has been 80 to 100 percent of average.

NEBRASKA—Water supply along the North Platte was adequate for irrigation use this year. Summer rainfall was slightly less than normal. Runoff in the North Platte and its tributaries from Colorado and Wyoming mountains was about three-quarters of normal and somewhat less than expected. Depletion of storage in the major reservoirs on the North Platte in Wyoming provided more than the usual percentages of water available. Normal or better snowpack will be required to provide assured supplies for next year.

NEW MEXICO—Streamflow along the Rio Grande and its tributaries was only about 40 percent of normal. Better than normal carryover storage tended to relieve the deficiency in runoff. Areas without storage had a poor water supply. Soils were dry prior to the start of the irrigation season and in most cases remained dry. Pumping was heavy. Carryover storage in Elephant Butte and Caballo reservoirs is 575,000 as compared to 1,080,000 acre-feet at this time last year.

Water supply on the Carlsbad Project was good due to excellent carryover storage and average precipitation. Carryover storage is now better than normal.

The Arch Hurley Conservancy District started the season with a nearly full reservoir and ended the season in the same position. Prospects for next year's water supply are good in this area.

Along the Rio Grande a heavy snowfall in the mountains will be necessary to insure good water supply for next year.

NEVADA—As was forecast, extremely low streamflow was experienced throughout Nevada during 1959. Dry

Construction and Materials for Which Bids Will Be Requested Through December 1959*

Project	Description of work or material
Boulder Canyon Project, Nev.	Installing cement mortar lining in about 10,000 linear feet of 6- and 8-inch cast-iron water mains in Boulder City.
Central Utah, Utah.	Clearing about 240 acres of trees and brush, 11 miles of fencing, and 3 farm sites in the Stanaker reservoir site, north of Vernal.
Central Valley, Calif.	Constructing 16 miles of 6- to 33-inch pipelines for hydrostatic heads varying from 25 to 200 feet. The specifications will include alternate bids for the pipelines of concrete pressure pipe, mortar-lined and coated-steel pipe, cement-asbestos pipe, pretensioned concrete cylinder pipe and noncylinder prestressed pipe within acceptable limits of sizes and heads. Work will also include constructing 4 small pumping plants. Tea Pot Dome laterals, near Porterville.
Do	1 hoist, stems, and support beams for 10- by 20-foot fixed-wheel penstock gate for Trinity Dam.
Colorado River Storage, Ariz.	2 300-ton overhead traveling cranes and one set of lifting beams for Glen Canyon powerplant.
Do	1 75-ton overhead traveling crane for machine shop at Glen Canyon powerplant.
Colorado River Storage, Utah.	3 50,000-hp., 240-r.p.m., 365-foot-head, vertical-shaft, Francis-type hydraulic turbines for Flaming Gorge powerplant.
Columbia Basin, Wash.	Earthwork and structures for about 7.7 miles of concrete-lined laterals, 54.5 miles of unlined laterals, 23.4 miles of compacted earth-lined laterals, and 9 miles of wasteways and drains in Blocks 18, 19, 20, 42, 45, 46, 47, 74, 80, 88, and 89 in vicinities of Othello, Connell, Moses Lake, Mesa, Warden, and Quincy.
Do	Constructing 8 2-bedroom frame residences with full basements and attached garages, a 28- by 112-foot concrete-block garage and a 36- by 52-foot concrete-block shop building, both with truss roofs, and complete water and sewerage facilities.
Klamath, Calif.	Earthwork and structures for about 10 miles of earth-lined canals, laterals, and drains, about 10 miles southwest of Tule Lake.
Lower Rio Grande Rehabilitation, Tex.	Rehabilitating about 9 miles of lateral consisting of reshaping the prism and banks and constructing unreinforced concrete lining with bottom widths of 5 and 3 feet in the new section. Work will also include constructing timber slide-gate checks, concrete bridge, turnouts, drainage culverts, and road crossings.
MRB, Kans.	Earthwork and structures for 6.9 miles of canal, 4.8 miles of open laterals, and 1 51-c.f.s. pumping plant. Courtland No. 1.
MRB, Nebr.	Earthwork and structures for about 15 miles of 12- to 5-foot bottom width canal, about 21.5 miles of 6- to 3-foot bottom width laterals and wasteways, and about 1.7 miles of 15- to 8-foot bottom width drains. Culbertson extension canal.
MRB, N. Dak.	Stage 03 additions at Devils Lake substation will consist of constructing concrete foundations, furnishing and erecting steel structures, installing a 10-mvar-46-kv. capacitor bank and associated electrical equipment, major items of which will be Government-furnished.
Do	Stage 04 additions at Jamestown substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing 2 230-kv. circuit breakers, a 5,000-kv.-a. reactor and associated electrical equipment, major items of which will be Government-furnished. Stage 05 additions at Fargo substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing a 5,000-kv.-a. reactor and associated electrical equipment, major items of which will be Government-furnished.
Do	Stages 03 and 04 additions at Bismarck substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing 2 230-kv. circuit breakers and associated electrical equipment, major items of which will be Government furnished.
MRB, S. Dak.	Earthwork and furnishing and applying asphaltic membrane material covering for impervious membrane lining for 8,600 linear feet of canal. Angostura canal, near Oral.
Do	Stage 03 additions at Tyndall substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing 1 15-kv. circuit breaker and associated electrical equipment, major items of which will be Government-furnished.
Do	Stage 03 additions at Huron substation will consist of regrading the existing area, constructing concrete foundations, furnishing and erecting steel structures, and installing a 60,000-kv.-a. bank of single-phase 230/115-kv. autotransformers, 1 115-kv. and 2 230-kv. circuit breakers, and associated electrical equipment, major items of which will be Government-furnished.
MRB, Wyo.	Additions at Cheyenne substation will consist of grading and fencing an extension to the existing area, constructing concrete foundations, furnishing and erecting a steel structure, and installing 3 115-kv. circuit breakers and associated electrical equipment, major items of which will be Government-furnished.
Parker-Davis, Ariz.	Constructing 5 or 6 3-bedroom frame or frame stucco residences at Davis Dam Government camp.
Washita Basin, Okla.	Constructing a chlorination station at Fort Cobb dam will consist of constructing a 37- by 17-foot reinforced concrete block building, and installing Government-furnished chlorination equipment.

*Subject to change.

soils under the below normal mountain snowpack deducted a large percentage of last spring's snowmelt runoff. Abnormally cold spring temperatures delayed early runoff and in some cases snowmelt peak flows never occurred. The Humboldt River at Palisade had an 8 percent of normal (1938–52) April–July flow; the Carson River near Carson City had a 29 percent of normal April–July flow; and Lake Tahoe inflow during April–July was 31 percent of normal.

Water users served from reservoirs had a fairly adequate supply due largely to last year's reservoir carryover. Water users served from natural flow had a poor year.

Heavy reservoir drawdowns have been used to augment the low streamflow. Carryover storage is very low except for Lake Tahoe, which now has about 425,000 acre-feet in storage, or 95 percent of normal.

OKLAHOMA—Water supply for the W. C. Austin Project was slightly better than normal. Crop production was near average. Lake Altus has nearly the same amount of water as a year ago. Fall precipitation has been good, and soil moisture conditions are good to excellent.

OREGON—Irrigation water supplies during 1959 were extremely short in south-central, central, and southeastern Oregon, except where large storage facilities were available. Reports indicate that crop production was relatively good in most areas of the state, even if streamflow was low. Actual water supplies were very close to that indicated by the April 1 snowpack.

Outlook for next irrigation season is poor in terms of stored water, but mountain soils are well primed as a result of recent storms. Fall rains have been three to five times normal in eastern Oregon, and near normal in the southeastern part of the state. Carryover storage in 25 reservoirs is only 42 percent of normal.

SOUTH DAKOTA—Irrigation water supply for the Black Hills area of South Dakota was deficient this year. Runoff was much below normal. There was a long period of drouth in late summer. Reservoir storage has been depleted to near the lowest point of record.

TEXAS—There was no reduction in crop production in western Texas due primarily to the carryover storage in Elephant Butte. No material reduction in crops occurred along the Pecos even though the runoff was extremely light. Heavy pumping helped make up the shortage of streamflow.

UTAH—Water supplies in Utah this summer were about as anticipated last spring. They varied from generally adequate to limited shortages in the northern part of the state, with limited to severe shortages in central areas. In the south, shortages have been severe except for those users who pump from ground water or who had good water supplies stored in reservoirs as a carryover from 1958. Frequent showers the last of July, the first of August and during September materially helped the water supply situation in many areas.

If water supplies for 1960 are to be adequate, an above average snowpack will be needed next winter. The poor

Continued on P. 4 of Cover

U.S. GOVERNMENT PRINTING OFFICE: 1959 O—524938

MAJOR RECENT CONTRACT AWARDS*

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-5192	Colorado River Storage, Ariz.-Utah.	July 16	4 40-foot by 52.5-foot radial gates for Glen Canyon dam spillways.	Vereinigte Osterreichische Eisen—und Stahlwerke Aktiengesellschaft, Linz/Donau, Austria.	$309,850
DS-5196	Missouri River Basin, N. Dak.	July 17	2 230-kv. power circuit breakers for Jamestown substation, Schedule 1.	Brown Boveri Corp., New York, N.Y.	142,225
DS-5200	do	July 21	2 230-kv. power circuit breakers for Bismarck substation	do	142,225
DC-5202	Central Valley, Calif.	July 10	Construction of earthwork, structures, and gravel surfacing for relocation of Trinity County road, Cedar Creek to Nelson Creek Gap.	Floyd R. Grubb, Salem, Oreg.	574,959
DS-5208	Missouri River Basin, S. Dak.	Sept 10	12 230-kv. power circuit breakers for Fort Thompson substation, Schedule 1.	American Elin Corp., New York, N.Y.	808,900
DS-5213	Colorado River Storage, Ariz.-Utah.	Aug. 14	4 100,000-pound radial-gate hoists for spillways at Glen Canyon Dam.	Moffett Engineering, Inc., Berkeley, Calif.	104,000
DC-5214	Missouri River Basin, Nebr.	Aug. 7	Construction of Sherman Dam	J. A. Tobin, Construction Co., Kansas City, Kans.	2,149,380
DC-5215	Rogue River Basin, Oreg.	Aug. 31	Construction of major structures for East lateral rehabilitation.	Pegram Construction Co., Othello, Wash.	268,016
DS-5216	Colorado River Storage, Ariz.-Utah.	Aug. 27	6 7-foot by 10.5-foot outlet gate valves, conduit liners, anchor bolts, and piezometer piping for left diversion tunnel outlet works at Glen Canyon Dam.	Yuba Consolidated Industries, Inc., Yuba Manufacturing Division, Benicia, Calif.	509,655
DC-5219	Rogue River Basin, Oreg.	Sept. 4	Construction of Billings siphon, West lateral rehabilitation, utilizing pretensioned concrete siphon pipe, Schedule 1.	C. H. Strong, Engineering and Construction, Eugene, Oreg.	156,481
DC-5220	Missouri River Basin, Wyo.	Sept. 18	Construction of Gray Reef Dam	Davis Construction Co., Inc., Grand Junction, Colo.	593,237
DC-5221	Missouri River Basin, Nebr.	Sept. 24	Construction of earthwork and structures, including 5 canal siphons, for Culbertson extension canal, Station 1126+00 to 1719+00; and laterals, wasteways, and drains, utilizing monolithic concrete in 81- and 87-inch diameter siphon barrels. Schedules 1, 2, and 4.	Bushman Construction Co., St. Joseph, Mo.	1,539,106
200C-419A	Central Valley, Calif.	Sept. 17	Clearing 5,595 acres of Trinity reservoir site, Trinity Center, East Fork, and Trinity River areas.	R. W. Byers, Redding, Calif.	511,100
200C-499	Missouri River Basin, Kans.	Aug. 7	Construction of earthwork and structures for Pump No. 4 canal, Pump No. 4 West Canal, pumping plant, discharge lines, and Pump No. 4 West laterals P4W-0.2 and P4W-0.8.	Bushman Construction Co., St. Joseph, Mo.	112,391

WATER

NOT FOR WATER ALONE

Look at your water bill; then look behind it. Consider some items which might well appear, but don't.

There's no reference to medical service, yet the health of your community, of your family, and of yourself is protected by the vigilance of the men who check and treat and recheck water to make sure it's safe for you.

There's no fee for securing reduced fire insurance rates, yet the whole schedule of these rates is substantially reduced if an adequate public water supply—so necessary to an effective defense against fire—is available.

There's no contribution levied for community development, yet key industries can produce goods and provide employment only because a dependable water supply is available.

Without a continuing flow of water, sewers could not be properly flushed or streets kept clean.

You could conceivably obtain enough water through your own efforts to satisfy your thirst, clean your body, and water your garden. But only through an organized system of collection, storage, distribution, and treatment can water resources be mobilized to produce the broader benefits which you. as a citizen, enjoy.

The price which you and all consumers pay for water you use helps to meet the costs of making these benefits available to all.

Without a water works system, the cost of urban living would be prohibitive!

WATER

IT TOOK A LOT OF MONEY

Your water system serves you by securing water, by storing water, by testing and purifying water to make it safe for use, and by delivering water into your home or place of business.

These things it is able to do because substantial sums of money have been expended on equipment and installations which perform these functions.

Fortunately, most of us benefit by expenditures made over a period of years, including periods when prices were much lower than they are now. Yet even in terms of 1940 prices, when most commodities cost less than half what they do now, water works facilities cost real money.

A 2-billion gallon reservoir, then big enough to provide a 200-day supply for a city of 100,000, cost $2,500,000 in 1940.

The pumping station required to move this water through the city's mains cost $100,000 to build and equip.

A mile of 8-inch cast iron pipe, of the type used for water mains in residential areas, cost $6,500, and under normal conditions cost another $4,500 to install.

An elevated storage tank of 125,000-gallon capacity, of the type you'll see serving small towns and villages cost $18,000.

A filtration plant for a fairly large city cost $1,850,000.

Whether financed by private capital or a municipal authority, a water works has always represented a major investment, ranging from $50 to $100 per person served.

Regardless of prevailing prices, it has always taken a lot of money to bring you safe, usable water.

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Continued from P. 112

summer just ending will have a major influence on next year's water supply since reservoir storage has been so severely depleted. Of 15 reporting reservoirs, only the three largest have above average carryover supplies. Of the remaining 12 reservoirs, seven have a carryover which averages only 6 percent of capacity.

Unless October and November prove to be dry months, soil moisture conditions will not be detrimental to next year's water supply. At present, principally as a result of September storms, soil moisture is average or above in northern watersheds, about average in the center of the state, and slightly below average (about 15%) in the south.

WASHINGTON—Generally adequate water for irrigation and other purposes was available throughout the state during the 1959 season. Runoff was normal or slightly above in April and May and well above normal during June, July and August. An exception was in the south and extreme southeastern part of the state where poor runoff was experienced throughout the summer.

There was very little high water on any of the tributaries in the state. Minor floods were confined to local areas.

Precipitation followed the runoff pattern to a very close degree with below normal precipitation during the earlier part of the summer, followed by above normal during the latter months. September reports from selected precipitation stations indicate rain fell in excess of 200 percent of normal. This precipitation has primed the mountain soils which will tend to increase runoff next year.

Reservoir carryover is excellent for the major irrigation reservoirs in the state and the outlook for the 1960 irrigation season is very good unless there is an extremely poor snowpack this winter.

WYOMING—Streamflow during the summer months was slightly less than normal no Bighorn River tributaries in the northwest part of the state. There was some depletion in storage in major reservoirs for irrigation use in late summer. The flow of the Green River in western Wyoming was about 80 percent of normal.

The flow of the North Platte into Seminoe Reservoir was about 75 percent of normal. Water supplies along the North Platte in eastern Wyoming were adequate at the expense of a decrease in total storage in large reservoirs on the main stem. Some shortage of water occurred along the Laramie River. Northwestern Wyoming was extremely dry. # # #

The Reclamation Era

FEBRUARY 1960

IN THIS ISSUE:

"What's Comin' " in Sugar Beets

Why Reclamation?

Official Publication of the Bureau of Reclamation

The Reclamation Era

FEBRUARY 1960 **VOLUME 46, NO. 1**

In this issue . . .

J. J. McCARTHY, Editor

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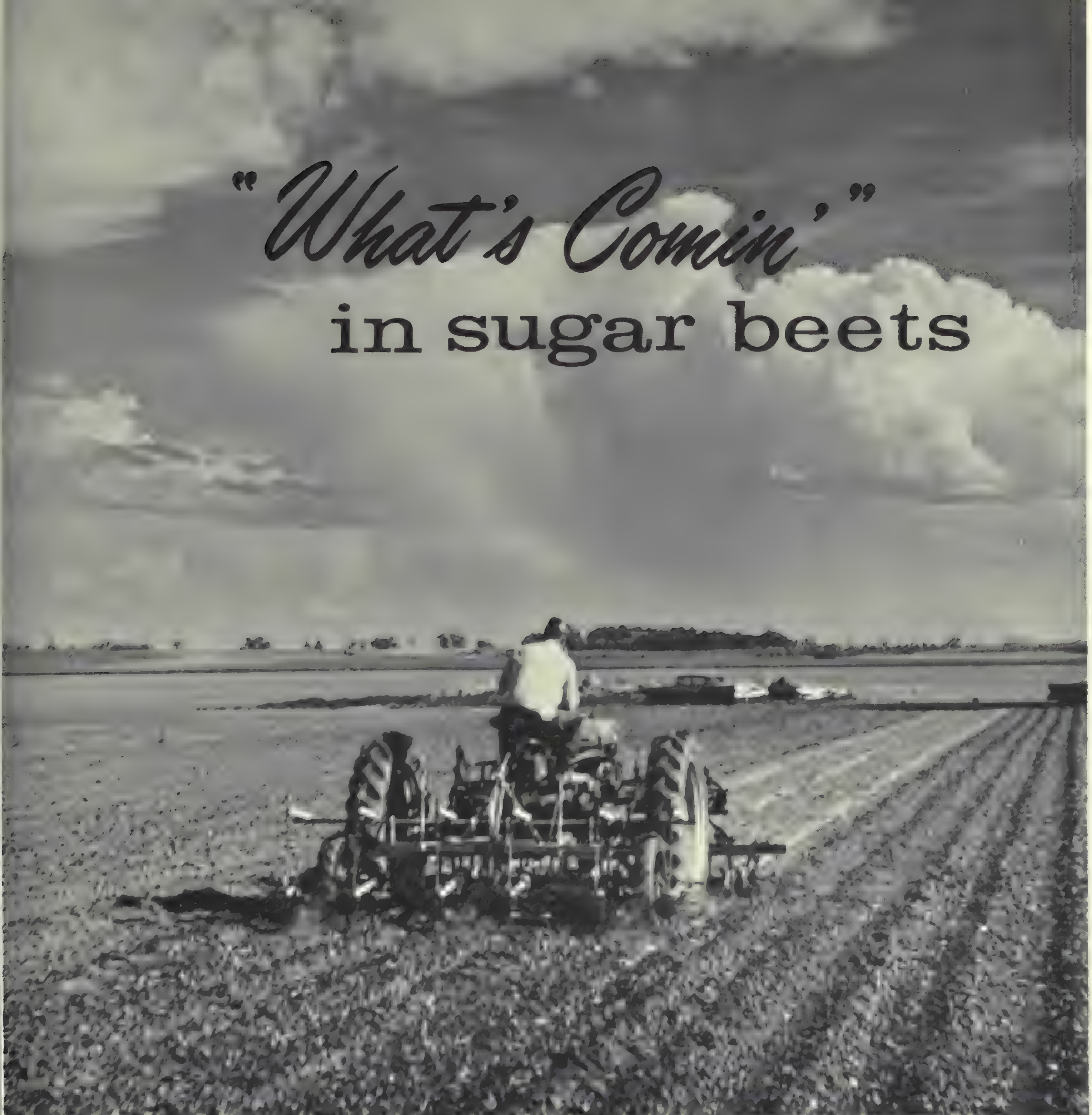
"What's Comin'" in sugar beets



The production of sugar beets has made mag-
ıificent advances in the past few years, but pres-
ınt research findings indicate we are actually
ust on the verge of a period of unusual develop-
ıent in the production of this high energy-
ielding crop.

New discoveries in genetices, chemistry,
ıechanization, and utilization make possible in-
reases in efficiency not thought possible a few
ears ago. The purpose of this short article will
e to discuss some of the things in the offing.

Perhaps one can judge the future better by comparing it with the past. Take a look at the accompanying chart, which shows the yields per acre (in tons) as an average of all the 22 States producing sugar beets, and you will readily recognize that terrific gains have been made prior to this time. If you compare the average yield of the 5 years just before World War II with the average

by P. B. SMITH

General Agriculturist of the Great Western Sugar Company and the Northern Ohio Sugar Company, President of the Western Seed Production Corporation and Director of the Beet Sugar Development Foundation.

of the last 5 years, 1954 through 1958, you will note that the gain in production per acre amounts to 39 percent.

A casual observer might think that with this tremendous gain just behind us, yields probably will level off in future years. Actually, through new techniques in genetics, such as hybrids and polyploids that might contribute still higher yields, within 10 years there should be a gain of at least 15 to 20 percent over the high figures of today. It is apparent that our plant breeders probably will realize more increase per acre through use of suitable hybrids than the corn-grower has realized from the same genetic tools.

Gains in yields, startling as they are, are not nearly as dramatic as the gains in mechanization during the last few years.

Since 1946 the mechanical beet harvester has taken over to the extent that it has entirely eliminated the need for hand work in the fall. Probably no other crop has so rapidly mechanized its harvest. One man on a harvester today replaces from 8 to 20 hand toppers, depending on the scale of operation. Mechanical harvesters vary from one-row to three- and four-row machines that are capable of taking out as much as 20 acres each in a day. The quality of the work for the most part is superior to that of the old hand methods, and the machines are dependable in practically all soil conditions.

Before World War II, each ton of beets harvested required approximately 5.4 man-hours of field labor, both in the spring and in the fall. Today it's posible, through the use of harvesters, machine thinners, and selective weed killers applied to monogerm seed, to raise the average crop with only .12 man-hours per ton consumed by hand labor. This, of course, combines efficiency of methods with gains in yield. Farsighted beet growers are already looking forward to total elimination of field workers, and many the past two years have approached this long sought goal.

This, again, is not the complete story. Improvements are being made in control of insects and diseases and in responses to hormone chemicals that appear to have tremendous possibilities for boosting yields. Startling as it may seem, experiments with Gibberellic acid in the past 2 years, with 10 grams applied per acre a month to 6 weeks in advance of harvest, have resulted in yield increases as much as 2½ tons per acre. We don't know too much about the commercial adaptation

New beet drills allow improved spacing of monogerm seec With new cold-resistant varieties farmers are planting 2 an 3 weeks earlier. Here Colorado Rockies furnish backdrop.

of these things yet, but they are in the field testing stage.

When you add together the benefits of monogerm seed, improved beet drilling equipment, improved fertilizing practices, selective weed herbicides, machine stand control, improved insecticides, fungicides, nematocides, one-man mechanical harvesters, and growth producing chemicals—combined with the potential improvement from genetic advances—the rapidity of gains envisioned here is a challenge to the imagination. I am confident that these scientific developments, properly directed, will effectuate larger sugar beet crops with less effort than anyone previously even dreamed about.

Another subject which must be considered is the knowledge that we are gaining on utilization of the valuable constituents of the sugar beet.

An acre of beet tops, for example, produces live stock feed nutrients equal to the nutrients in alfalfa raised on the same acre, and we are learning ways to utilize more fully this valuable annual crop of tops.

We are also discovering new compounds imbedded in the root of the beet, and developing ways to use them. Some are already of commercial importance, such as the condiment, monosodium glutamate, which enhances the flavor of foods for American consumers and which the sugar beet plant produces in large quantities. Re-

Growing of beet seed is becoming important adjunct to irrigated crop economies of Arizona, southern California, and parts of Oregon.

Scientists are busy developing building blocks for new varieties. Here are some of over 3,000 inbred strains grown for indexing and testing as to future possibilities.

Selective weed chemicals sprayed directly over row are stirred into surface soil in 6-in-wide band, followed by beet drill putting seed at proper depth—all in a one-machine operation.

Complicated uniting of important genes in interspecies crosses will benefit beet grower.

searchers are already indexing many other important substances that can contribute to the overall welfare of the sugar beet industry.

With our rapidly expanding U.S. population, the sugar beet crop will have a growing, marked effect on an important industry in the West as well as the development of our irrigated sections of America. ###

Salt River Sports

If all of the Salt River project's six lakes on the Salt and Verde Rivers were half full, recreational value of these bodies of water would be worth about $19,838,000 per year to the economy of Arizona.

This estimate is based on the result of an economic survey made by the Arizona Game and Fish Department and was disclosed by Wendell G. Swank, the department's assistant director, at a meeting of the Arizona Water Resources Committee.

"On the basis of our study," Mr. Swank said, "we found that each acre of fishing water is worth about $1,000 per year to the economy of the State. Hunting and fishing in Arizona amounted to $43 million in 1956, which is bigger than many of the businesses we normally think of as big business."

Roosevelt Lake, impounded by Roosevelt Dam, which is often referred to as the keystone of the Valley's economy, offers 12,840 acres of fishing water when filled 50-percent capacity. Horseshoe Lake has a 50-percent capacity of 1,960 acres; Apache Lake, 1,776; Bartlett, 1,711; Saguaro Lake, 878, and Canyon Lake, 673.

The project has been lauded time and again for its cooperation with the Game and Fish Commission, and as a result of this cooperative program most of the lakes are available for year-round fishing. Project officials extend every effort to make the storage reservoirs attractive to fishermen. Wherever possible project operations coincide with recommendations of Game and Fish Department biologists.

Early in April executives of the project and AGFD held their second annual planning session at which time the project agreed to hold levels of Roosevelt and Canyon Lakes within a foot variation during the bass spawning season during late April and early May. Water was drawn from Apache Lake during the critical period. Saguaro Lake was filling during the same period but this was not expected to affect the spawn.

Department biologists said Roosevelt and Canyon were most in need of heavy spawning the past spring. Saguaro and Bartlett were rated next in importance. Water from Horseshoe was used to maintain a constant level on Bartlett.

Dropping of the water level behind Horse Mesa Dam had no harmful effect on fishing there because Apache Lake has a well balanced fish population and fishing there should be good for a number of years.

Although lakes in the Salt River project storage system were created primarily to provide the Valley with a constant source of life-giving water, they are attracting more and more recreational enthusiasts every year. Each weekend, and on weekdays, too, the train of boats to and from the lakes is an ever-increasing thing.

Through construction of four dams on the Salt River and two on the Verde, the project created these popular recreational centers. The expense of construction and maintenance is borne solely by the project without any cost whatsoever to the taxpayers of Arizona.

Last year the 6 lakes attracted 444,500 people for fishing, boating, and picnicing with 378,000 visiting the Salt River lakes and 66,500 enjoying those of the Verde system. These statistics were supplied by the U.S. Forest Service whose rangers keep a pretty close tab on the manner in which various natural resources are utilized.

The Salt River project is adhering to the principles of multiple use—"the greatest good for the greatest number of people." #

REDUCING RESERVOIR EVAPORATION

Working in cooperation with engineers and scientists of other governmental agencies, Bureau of Reclamation research scientists have demonstrated that techniques are available to reduce evaporation from large reservoirs by placement of a film-forming chemical on the water surfaces. This is the conclusion reached by the committee of collaborators from Federal, State, and municipal agencies who, during the period of July 7 to October 1, 1958, performed at Lake Hefner, Oklahoma City, Okla., one of the most comprehensive experiments ever undertaken in the field of reservoir evaporation.

The chemical film the researchers at Lake Hefner had under study was composed of the compound hexadecanol, also known as cetyl alcohol. When hexadecanol is spread on a water surface, it forms a film or monomolecular layer—an invisible shield between the water and the surrounding air, one molecule or about 6 ten-millionths of an inch thick. The layer forms because the molecules aline side by side, the hydrophilic or "water loving" end in the water and the hydrophobic, or "water fearing," end in the air. The alinement is similar to paper matches in a matchbook and forms an invisible and pliable layer on the water surface, which prevents escape of water molecules to the surrounding air.

The study of the phenomenon of the monomolecular layer has been under way in laboratory investigations for more than 30 years. But the question of the method of application to a large body of water and the host of accompanying questions, including the important effect of the layer on aquatic wildlife and on humans, required the concerted effort of scientific teamwork for resolution at a suitable reservoir of sufficient area.

by L. O. TIMBLIN, Jr.

Physicist, Division of Engineering Laboratories, Commissioner's Office, Denver, Colo.

The chairman of the committee of collaborators was Grant Bloodgood, Assistant Commissioner and Chief Engineer of the Bureau of Reclamation. Members of the committee included representatives from the city of Oklahoma City; Oklahoma State Department of Health; Public Health Service, Department of Health, Education, and Welfare; Weather Bureau, Department of Commerce; the Geological Survey and the Bureau of Reclamation of the Department of the Interior.

Many reservoirs were considered for the large-scale field tests. However, Lake Hefner, a municipal water supply reservoir about 2,500 acres in area and a part of the water supply system for Oklahoma City, was chosen because of several factors, including the size of the lake, geographic location, and meteorologic conditions existing there during the summer and early fall months. Most significantly, the fact that a detailed "water budget" (accurate data on the inflow and outflow of water), including data on evaporation losses which had been earlier determined by several cooperating organizations, demonstrated the feasibility of conducting the accurate evaporation studies at the lake.

In June 1959, a final report by the committee of collaborators was issued giving the results of each phase of the study. The following is the joint statement of the committee included in the final report:

"It has been demonstrated by the Bureau of Reclamation that techniques are available to cover the 2,500-acre Lake Hefner with a fully compressed layer of hexadecanol, given favorable conditions. The Geological Survey obtained the data needed to evaluate the success of the film in suppressing evaporation. Techniques developed as the result of research in recent years were used to measure the actual evaporation and to compute the evaporation that would have occurred if no

Aerial view of Lake Hefner, Okla., from southern shore. Monomolecular layer of hexadecanol is lighter area. (George Casperson, *Tinker AFB*).

film had been applied. The Geological Survey's evaluation showed that during the period of treatment, July 7–October 1, 1958, it was possible to achieve an overall reduction in evaporation of slightly more than 9 percent, although weather conditions were not favorable for maintaining the film.

"It has been demonstrated that the effectiveness of evaporation retardants is lessened at higher temperatures, and the 9 percent reduction achieved is about one-fourth of the potential reduction with the kind of material used at Lake Hefner and at the water temperatures experienced. The water savings by evaporation reduction at Lake Hefner were accomplished at a total cost for labor and hexadecanol approximately equal to the total value of the untreated water saved to Oklahoma City.

"No hexadecanol could be detected by the Public Health Service in water reaching the inlet of the Oklahoma City water supply. Oklahoma City officials found that concentrations of micro-organisms normally present in lake waters increased markedly as a result of feeding on the hexadecanol. However, the purified water met Public Health Service drinking-water standards.

"The wind has a very pronounced effect on the behavior of the film. With wind velocities greater than about 20 miles per hour, it was found impractical to maintain a film on Lake Hefner.

"It may be expected that under an operational program with improved procedures and materials, the cost of evaporation reduction would be considerably less than experienced in the Lake Hefner trial."

The method chosen by Bureau of Reclamation scientists for applying the monolayer-forming compound to Lake Hefner was one in which a dry powder was mechanically suspended in water and sprayed onto the surface of the lake. Two separate identical suspending units were used in this operation; one unit was mounted in a 17-foot boat, and the other was mounted on a floating platform supported by four pontoons. The platform was propelled by a 25-horsepower outboard motor in normal operation; however, another 25-horsepower motor was mounted on the platform for emergency operation. The platform permitted easy access to the mixing equipment and permitted carrying loads of more than 1,000 pounds of the powdered materials. As much as 400 pounds of cetyl alcohol could be carried in the boat at a time, and this was adequate, as this was about one-half a day's supply for the lake.

The mixing and dispensing equipment consisted of two mixing units powered by a single engine

through a pully and clutch arrangement, which permitted the mixers to be run individually or simultaneously. The mixing chambers were made from 55-gallon oil drums. A single engine was used to power the intake and discharge pumps. With this equipment, water was pumped from the lake into the mixing chamber, where it was mixed with dry powdered alcohol introduced by hand scoops at the desired rate. Three mixing propellers quickly mixed the water and powder into a smooth uniform suspension, which then flowed into the discharge pump and was forced through a spray system onto the lake surface.

Applications, weather and other conditions permitting, were made during the daylight hours, 7 days a week. Often, crews started as early as 5 a.m. and worked as late as 6 p.m. Later in the summer, an effort was made to have the greatest film coverage coincide with the time of highest evaporation. During the summer, a total of 40,040 pounds of cetyl alcohol was applied to the lake.

For the 86 days of the application phase of the test, treatments were made for 55 days. Applications were not made for the remaining 31 days because of high winds, rain, high humidity, and maintenance and repair of equipment. The maximum coverage attained at any one time was 89 percent. Coverages exceeding 90 percent were not expected because of the many small shallow coves and bays along the parts of the lake shoreline. The maximum evaporation savings for any computation period of about 2 weeks was 14 percent, as compared to a possible maximum savings under prevailing water temperatures of about 35 percent.

Accounting of costs was an important factor in the evaluation of the results. Meticulous records were maintained on costs of hexadecanol applied, gasoline, oil and repairs for operations of boats, salaries and wages of operators and laborers, motor vehicle operation, rental of barge, equipment depreciation, and miscellaneous expenses.

(Continued on p. 26)

Stern view of barge used for dispensing hexadecanol at Lake Hefner. Barge could carry six to eight drums of alcohol. Equipment was easily accessible for repair.

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Action on the San Juan River

There is action on the San Juan River in northwestern New Mexico. Huge earthmoving machinery sends dust flying into the air about 40 miles east of Farmington where men have tackled the job of damming the San Juan River. Little-by-little and load-by-load, earth materials are being gouged from age-old resting places and transported to repose in the gigantic embankment being placed to impound the flows of the San Juan River. This is the Navajo Dam—the key to the future for the central San Juan River Basin.

Navajo Dam will soon rise as a huge mound of earth and rock standing nearly 40 stories above the bed of the San Juan River. Its crest will reach seven-tenths of a mile across the canyon. It will be the second largest earth dam to be built by the Bureau of Reclamation. (Only the Trinity Dam in California will be slightly larger.) It will be 2½ times the size of Grand Coulee Dam, the largest of all the concrete dams in the world.

Navajo Dam will be completed in about 3 years, and its 35-mile long reservoir will lie as a blue streak on the dry desert plateau. The facts and figures on Navajo Dam stagger the imagination. But, fascinating as they are, the significance of Navajo Dam, and the reservoir it will create, lies in what it will do to make possible the control and use of the meager but vital water resources in this corner of the arid West.

First, the role of Navajo Dam in the control of the San Juan River. Navajo Dam and Reservoir is one of a team of four initially authorized storage units of the Colorado River Storage Project. The Navajo Storage Unit (as the dam, reservoir, and related works are called), along with the Glen Canyon, Flaming Gorge, and Curecanti Storage Units on other rivers in the Upper Colorado Basin, will bring about major regulation of the natural stream flows of the Upper Colorado River System.

Like mammoth barrels, these storage unit reservoirs will be able to catch and hold the raging river flows in years of high runoff. Releases from the reservoirs can then be made in years of low runoff. With control of the Upper Basin rivers, regulated releases from these storage unit reservoirs will protect and meet on an assured, continuing basis the rights to water in the Lower Colorado River Basin. And with control, greatly expanded direct use of water for beneficial purposes can and will be made in future years on participating projects throughout the Upper Colorado River Basin States.

Navajo Dam will create the controlling storage reservoir—the new water barrel—on the San Juan River, the second largest tributary of the Colorado River.

And second, the role of Navajo Dam in making possible extensive use of San Juan River water in the State of New Mexico. When the Navajo Reservoir is filled, direct diversion of water can be made to the proposed Navajo Participating Project. By this project, the irrigation of 110,000 acres of dry, now unproductive land will bring, directly and indirectly, increased economic benefits to one-fifth of the Navajo Indians on the reservation, according to the Bureau of Indian Affairs.

Another proposed project, the San Juan-Chama Participating Project, will be made possible by the control and storage of the erratic San Juan

by HERBERT E. SIMISON, Special Services Officer, Salt Lake City, Utah

Machinery scooping up material in borrow area for placement on Navajo Dam on San Juan River.

River flows to be achieved by the Navajo Dam and Reservoir. Under the San Juan-Chama Project, water would be diverted from the San Juan River at a near-headwater point upstream from Navajo Dam to the Rio Grande River Basin where supplemental water for 225,000 acres of inadequately irrigated farmland and where additional municipal and industrial water supplies for Albuquerque and other New Mexico cities are sorely needed.

The importance of Navajo Dam looms clearly on the horizon. Navajo Dam and the water resource developments it will make possible herald the opening of another major chapter in the modern history of man's conquest of his environment in the arid regions of the West.

Navajo Dam is set in an area which has a long history dating back to the prehistoric Indians of the Mesa Verde and the early Spanish explorations in North America. The setting is the central part of the San Juan River Basin in northwest New Mexico. In this area, the San Juan River makes a gentle southward swing from its source in southern Colorado to the Four Corners, and thence west to join the Colorado River in southern Utah.

The area is dry, hot, and windy plateau country. Rainfall is less than 10 inches, and elevations range from 5,000 feet to more than 6,000 feet. But the growing season averages about 160 days so that, if irrigation water is available, a

wide array of field, garden, and fruit crops can be grown.

Prehistoric Indians lived on the Mesa Verde, a somewhat verdant highland just north of the San Juan River. Their survival was based on meager rainfall and perhaps some crude irrigation. With the onslaught of a prolonged dry cycle in about A.D. 1300 these early inhabitants were forced to migrate generally to the south. Undoubtedly, they crossed the San Juan River, but control and use of that water was clearly beyond their ability. So, it is believed, they moved on to the Rio Grande Basin to found the famous Pueblo Indian cultures.

The Navajos are believed to have come to the San Juan in the late 14th and early 15th centuries and to have made some use of the river for the rudimentary irrigation of crops. The first white settlement began about 1880, and by the early years of the 20th century some 20,000 acres of land were in agricultural production. The agricultural situation has changed but little in subsequent years, except that farms have been subdivided until all but a small percentage (probably less than 10 percent), are now full-time farms.

But, since World War II, there has been great change in the area along the San Juan River in New Mexico. Farmington, the largest city has boomed in population from 3,500 to more than 20,000. Natural gas production has been the the principal reason. Many wells have been drilled, and gas is collected and piped to market points in the Western States. The mining of

Construction forms and placing foundation anchor bars for outlet-works stilling basin, Navajo Dam.

Dumpster is dwarfed in the outlet portal of 22-foot tunnel constructed to carry water around damsite.

atomic ores has been another factor in the postwar growth. Several small industrial plants have been established for the extraction of gasoline, sulphur, and other productions from natural gas and for the processing of uranium and other strategic ores.

Plans are in the formative stages for the development and use of the tremendous bodies of coal which underlie the area, and the future may see extensive coal-based industrial developments.

Navajo Dam will be the key to future agricultural and industrial growth in the area. Water is a "must" in this arid land, and the Navajo Reservoir can provide a reliable supply.

Construction of a dam on the San Juan was merely a dream for many years; now it is becoming a reality. By the fall months of 1959, about 8,000,000 cubic yards of the 26,300,000 cubic yards of earth and rock had been placed in the dam.

The ultimate size of Navajo Dam is difficult to comprehend. If a single train were to carry all the earth and rock to be placed in the dam, it would have to be 6,500 miles long. If this train were to go through your town at 50 miles per hour, you would have to wait at the crossing nearly 5½ days for it to pass by.

Actually, however, the materials used in building Navajo Dam are obtained from nearby carefully selected natural deposits of suitable earth and rock. These materials are located in what are called borrow areas. First, the borrow areas are soaked thoroughly with water pumped from the San Juan River, or are located in river bed areas

Artist's drawing of completed Navajo Dam. Completed structure will stand nearly 40 stories above San Juan riverbed.

that are naturally wet. When the moisture content of the borrow areas is determined to be just right, the earth is loaded into the big earthmovers and hauled to the damsite. There, the earth is spread and rolled until tightly compacted.

But, before the earth is placed in the dam, the foundation must be prepared. The loose surface materials are removed so that bedrock is exposed. Then, along the axis of the dam, holes are drilled deep into the bedrock. Grout, which is a mixture of water and cement, is pumped into these holes at high pressure so that the cracks and openings in the bed rock are filled. Thus, a deep "curtain" of sealed bedrock is created below the earth dam.

Two tunnels have been drilled through the right abutment rock of the dam. These tunnels will handle the flows of the San Juan River during the building of the dam, and will be used to release water from the reservoir after the dam is completed.

The spillway is located on the right abutment. It will be a concrete chute-type spillway, which will vary in width from 138 feet in the chute section to 195 feet in the stilling basin at the bottom end of the spillway.

The dam itself when completed will be a huge wedge-shaped mound of earth and rock. The upstream and downstream slopes of the wedge will be very gentle. The slopes will vary from 2:1 to 5:1. That is, the slopes will rise 1 foot vertically in from 2 to 5 feet of horizontal distance.

The core of the dam will be earth compacted to the maximum extent possible; this is called the impervious zone. Earth and rock zones flank this core and are pervious or semipervious. Banked up against the core, they are free-draining and give the dam bulk and stability.

The Navajo Storage Unit—the dam and all related features—will cost an estimated $42 million. The $22.8-million prime contract for construction of the dam was awarded in June 1958 to a combination of firms which includes the Morrison-Knudsen Co., Henry J. Kaiser Co., and the F&S Construction Co. By fall 1959, work under the prime contract was well ahead of schedule.

Need for water increases as industry increases. Here is natural gas pumping plant at Kirkland, N. Mex.

As Navajo Dam approaches completion, the reservoir will begin to fill. The reservoir will store 1,709,000 acre-feet of water when filled, and extend upstream on the San Juan River for 35 miles. Plans are being made for heavy recreational use of the reservoir. The superb recreational opportunities offered by the Navajo Reservoir are recognized, and facilities will be constructed on the reservoir so that full advantage can be taken of this bonus benefit that accrues to all reclamation lakes in the West.

The hum of activity at the Navajo damsite today is a whisper announcing the future activities and growth in the central San Juan Basin and in the State of New Mexico which will result, directly and indirectly, from Navajo Dam and its power to corral the waters of the San Juan River. # # #

Main Street of Farmington, N. Mex., community that serves construction workers at Navajo damsite.

SAFETY TRAINING SAVES A LIFE

Carl Lindh, a powerplant operator at the Bureau of Reclamation's Minidoka Dam near Rupert, Idaho, conclusively proved the value of his first aid and safety training when his quick and effective application of artificial respiration was credited with saving the life of a companion who had received a severe electric shock.

Mr. Lindh, during offduty hours, was assisting Marshall Eilers in the erection of a TV antenna near the Boersch Lake pumping station. A guy wire which Mr. Eilers was handling came into contact with a 34,500 volt transmission line, the electric shock knocking him to the ground from his position on a ladder. When Mr. Lindh looked around from his position on top of the house and failed to see his companion, he immediately descended and found Mr. Eilers lying unconscious on the ground, and not breathing.

Mr. Lindh immediately started giving artificial respiration to the victim, using the back pressure-arm life method which he had been taught as a part of his first aid training in the Minidoka powerplant. After several minutes, the victim was revived and taken to a doctor in Rupert, who gave Mr. Lindh's quick action credit for saving Mr. Eilers' life. What might otherwise have been a fatal accident thus resulted in only relatively minor treatment for shock and second degree burns on the hands.

Mr. Lindh, who is 27 years of age, has been an employee of the Bureau of Reclamation for 5 years, beginning as an engineering aide and transferring to powerplant operations in 1956. His action has been recognized by letters of commendation from the Commissioner of Reclamation and the Regional Director of Region 1. He attributes the success of his life-saving performance to the training he received as a Bureau of Reclamation employee. #

USDA Reports Costs of Aerial Spraying

The typical hourly cost of dusting or spraying crops from a 150-horsepower, two-seated plane is estimated to be $28.88, if the applicator uses his plane for 200 hours of flying time annually.

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Why Reclamation?

Much of our public thinking today is influenced by biased propaganda. Many articles are written without learning all the facts, presenting only part of the truth, which too often leaves the people either confused or prejudiced.

Reclamation has come in for its full share of this adverse publicity. Many think reclamation is mainly a public works venture, and that it is wholly unnecessary, especially at a time when we have a large surplus of some farm commodities. I do not pretend to be a writer, but I think the time to set the record straight is long overdue. I have had an opportunity which few others have had to see the great changes which have been brought about through irrigation and reclamation.

I was born in the Sun River Valley over seventy years ago, being one of a comparatively few still living who rode the wide open spaces in northern Montana in my boyhood when nearly all the residents either lived in the towns or the river valleys. Having been well acquainted with many of the first settlers in the area, I learned much of the history of events that happened before I was born. From all reports given me by these men, there was lush grass most everywhere on the ranges at that time. Although there were many thousands of buffalo, there were also many thousands of square miles for them to roam over.

The first large herd of cattle was trailed into the Sun River Country in 1870. As this was in the "chinook" belt and never a deep snow country, most of the cattle at that time were wintered on the ranges, finding shelter in rough "breaks" or deep coulees and in the timber of the river valleys. The wind usually blew soon after a snowstorm, leaving ridges or high places free of snow so the stock could graze.

Although the large herds of buffalo had been almost exterminated in the early eighties largely to control the Indians and force them onto reservations, the herds of horses and cattle increased tremendously. This caused overgrazing, making this a short grass country.

The first major disaster to strike the livestock men was the very severe winter of 1880–81. During that winter it has been estimated nearly 50,000 head of cattle perished between the Missouri River and the Canadian border. Another disastrous winter was that of 1886–87. This is the winter during which C. M. Russell painted his famous picture, "The Last of the Five Thousand." My father used to tell of seeing three head of cattle piled up where they had fallen. The two top ones were dead, and the one on the bottom alive and raising her head to look up at him.

The losses of these winters convinced the stockmen that they would need to have more hay to carry them through these emergencies. The first water-right application on Sun River was filed May 1, 1868, by a group of ranchers to obtain water to irrigate some of the valley land from the town of Sun River to the present town of Vaughn. The town of Sun River at that time was one of the few in the State where the stage road crossed the river via a toll bridge. It was the only town between Fort Benton, the head of navigation on the Missouri, and the gold mining camps in the southwestern part of Montana.

After the severe winter of 1886–87 there was much activity in the irrigation field, and nearly

by D. R. DAVIES

Early-day settler on Sun River who served for 34 years on Board of Commissioners of Greenfields Irrigation District until April 1959.

Remains of Fort Shaw Military

Above, remains of Fort Shaw Military Post, officers' quarters in foreground and portion of stone fortifications. Below, early-day threshing on Greenfields Division of Sun River Project before coming of irrigation.

Dry benchland on Sun-

ed in 1867, viewed from south.

Fortifications and buildings at Fort Shaw. (Fort Shaw photos by K. W. Harman, Bureau of Reclamation, Region 6.)

every river or creek in the area was diverted to irrigate as much land as possible in these valleys. Some of the ditches have since been abandoned, while others are still in use. All of these ditches, however, irrigated only a very small portion of the land, which still left a shortage of winter feed.

This was the situation when Theodore Roosevelt became President in 1901. Roosevelt had ranched in the West when a young man, and through his efforts the Reclamation Act was passed in 1902. He realized that only the Government could finance the building of great dams and other costly structures which were necessary

prior to irrigation.

First sod breaking on Fort Shaw Division, Sun River Project.

Part of Sun River Project with Fairfield in left background. Dark areas are cloud shadows. (Bureau of Reclamation, Region 6.)

to build large projects that alone could balance the economy of the semiarid Western States.

The first reclamation ditches on the Sun River Project were on the Fort Shaw Division, which was completed and opened to homestead entry June 11, 1908. Much of the land covered by this project was the former Fort Shaw Military Reservation. At this time homesteaders began to settle all over Montana in steadily increasing numbers, and in a very few years the public land was nearly all gone.

Construction of dike at Pishkun Reservoir, with elevated grader and dump wagons.

In order that the readers of this article might have a better understanding of the whole picture, I will try to explain what a tremendous change reclamation has made in our part of the country, the Sun River area.

The Fairfield Bench[1] is where the major portion of the Sun River Project lies, and is part of what is now known as the Greenfields Division.

When I used to ride over this area in my boyhood, about the turn of the century, there were many years when there was very little vegetation growing on these ranges, owing to overgrazing and short rainfall. The shallow lakes which the early pioneers spoke of had disappeared. There was not one human being living on this bench, and very few living on any part of what is now the Sun River Project. There were few watering places or springs. These were owned by a few stockmen who thought that if they controlled

[1] The term "bench" is one used in the West for a high plateau or tableland.

(Continued on p. 23)

DO-IT-YOURSELF TOURS AT PARKER AND DAVIS DAMS

The "do it yourself" tours of Parker and Davis Dams and their respective powerplants, inaugurated last year by the Parker-Davis Project, are steadily increasing in interest and popularity with the traveling public. The two powerplants are located on the lower Colorado River, below Hoover Dam and Powerplant. Both are some distance from transcontinental highways so that visitors must go out of their way to visit the areas. Despite these apparent disadvantages, visitors are now coming by the hundreds. For example, during Easter Week some 3,000 persons visited the Parker Dam and Powerplant area, situated at the terminus of an 18-mile "dead-end" road.

In reviewing the reasons for the success of the tours, Parker-Davis Project officials have concluded that the "self-guided" aspect itself is the most attractive, followed closely by the well-placed directional signs and markers, the brief pushbutton transcriptions describing specific operations, and the general layout of the powerplants which permit easy viewing of the most interesting parts, plus the fact that no charge is made because there is no measurable expense involved.

The internal layouts of the two powerplants are quite dissimilar, but essential features of the self-guided tours have been used to advantage at both locations, as follows:

1. Highway signs advise that the powerplants are open to the general public.

2. Signs at the powerplant indicate parking areas and hours (8 a.m. to 8 p.m. throughout the year), and arrows on the walkways lead to the powerplant entrances.

3. Elevators are self-operated, with controls installed so that visitors will be taken only to the floors included in the tours.

4. Security barriers are placed so that visitors

by DONAL EARL, Administrative Officer, Parker-Davis Project

Arrows point way to powerplant entrances.

cannot stray from the well-marked routes of the tours.

5. Brief (4 minute) pushbotton transcriptions may be heard outside each control room and also in the turbine galleries.

6. Informational literature is available.

7. Visitors have access to restrooms and drink-

Registers for visitors are maintained at the entrance and informational literature is available.

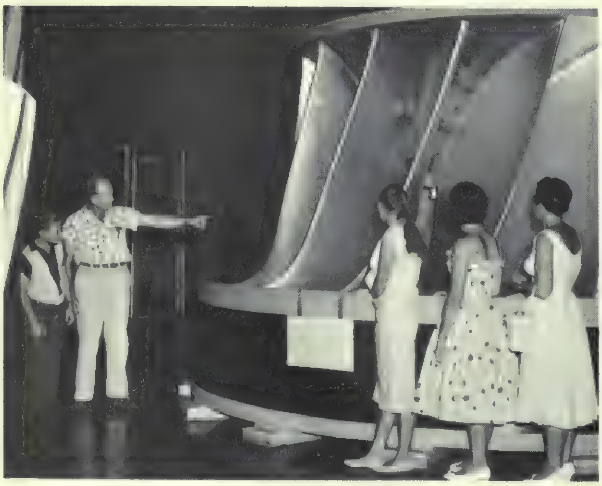
ing fountains, and, in addition, comfortable lounges are available.

A recent innovation is the installation of closed-circuit television receivers in the two control rooms. The television receivers automatically "sweep" certain areas of the tours. This enables the powerplant control room operators, who at times are the only employees on duty, to observe the visitors without having to leave the control rooms.

Registers for visitors are maintained at the entrance to each powerplant, but registration is optional. From the many favorable comments noted in the registers, it appears that the self-guided feature of the tours is the most welcome to the visiting public. They can take as little or as much time as they wish, without taking any employee's time.

* * *

Visitors inspect turbine runner.



Visitors view plaques giving historical facts on Parker-Davis Project.

HOOVER DAM TOWN TAKES OVER

BOULDER CITY as it looks today.

It's Boulder City, Nev., Incorporated!

This Reclamation community—established on Federal land 29 years ago as a construction camp for workers on Hoover Dam, and later serving as operational headquarters for Reclamation's Boulder Canyon Project and Region 3 offices—is now in the process of being transferred to the people for self-rule.

Boulder City voters last September 29 overwhelmingly approved a city charter providing for incorporation and on October 13 elected their first city council. The Clark County Board of County Commissioners officially declared Boulder City an incorporated Nevada municipality on October 20, 1959.

The Bureau of Reclamation has already sold its 179 housing units in the community, and is now disposing of certain other Federal property not needed for its operations.

The Boulder City charter, the result of 10 months' work by a 15-member charter commission and many years of effort on the part of a large segment of Boulderites, provides the people with the maximum home rule under the State laws and constitution, and the flexibility required to meet the problems of a newborn community. It provides for the council-manager type of government and establishes civil service and planning commissions, a municipal court, and a real estate board and officer. Other necessary departments are to be created by ordinance. The real estate board is required to manage, sell, or lease, subject to council approval, the 33 square miles of territory the city will acquire from the Government.

by HAROLD N. CORBIN, City Manager, Bureau of Reclamation, Boulder City, Nev.

Boulder City's first city council includes Robert N. Broadbent, who also serves as Boulder City's first mayor, Albert Franklin, Joseph C. Manix, Morgan J. Sweeney, and Dr. Thomas S. White. The council hired Curtis Blyth, former city manager of Bayside, Wis., a suburb of Milwaukee, as Boulder City's first city manager under an incorporated status.

Permissive legislation by the Congress of the United States, which would enable the people of Boulder City to incorporate was enacted on September 2, 1958.

Hoover Dam and the Lake Mead recreational area represent a mecca for more than three million visitors annually from every State in the Union and many foreign countries. Since most of these visitors pass through Boulder City, the national significance of the area will continue even though the Federal Government relinquishes control of the strictly municipal operations.

Boulder City started as a tent community in 1931, with beginning of construction on Hoover Dam, and from that was developed into a modern, well-planned city under the Bureau of Reclamation. Until incorporation, Boulder City's status was a reserve of public lands for Federal Government purposes. Boulder City's role as an isolated operating camp ceased long ago, but a continued requirement existed for a full-fledged community with all of the facilities, convenience, and necessities of a normal American city.

In 1949, the Bureau of Reclamation appointed Dr. Henry Reining, Jr., then Professor of Public Administration and Political Science at the University of Southern California, to make a survey and submit specific recommendations for resolution of the Boulder City situation. His report, entitled "Boulder City, Nevada, A Federal Municipality" (Sen. Doc. No. 196, 81st Cong.), dated May 18, 1950, was the basis of an order issued by the Secretary of the Interior in 1951, which administratively separated Boulder City from the Bureau of Reclamation.

Road relocation in Boulder City, Nevada. Tree-lined road on the right is Cherry and New Mexico. Highway in center is Nevada Highway.

AERIAL VIEW of Boulder City.

The order established the Boulder City Municipal Office, under the supervision of a city manager appointed by the Commissioner of Reclamation. An advisory council of seven members was created for consultation on all major decisions affecting administration, although it had no legislative authority. Three councilmen were appointed, and four were elected by the people.

Harold N. Corbin was appointed city manager of Boulder City in May 1952, having formerly served as administrative assistant to the city manager of Oakland, Calif., for eight years, and was city manager of Porterville, Calif., at the time of his appointment. # # #

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

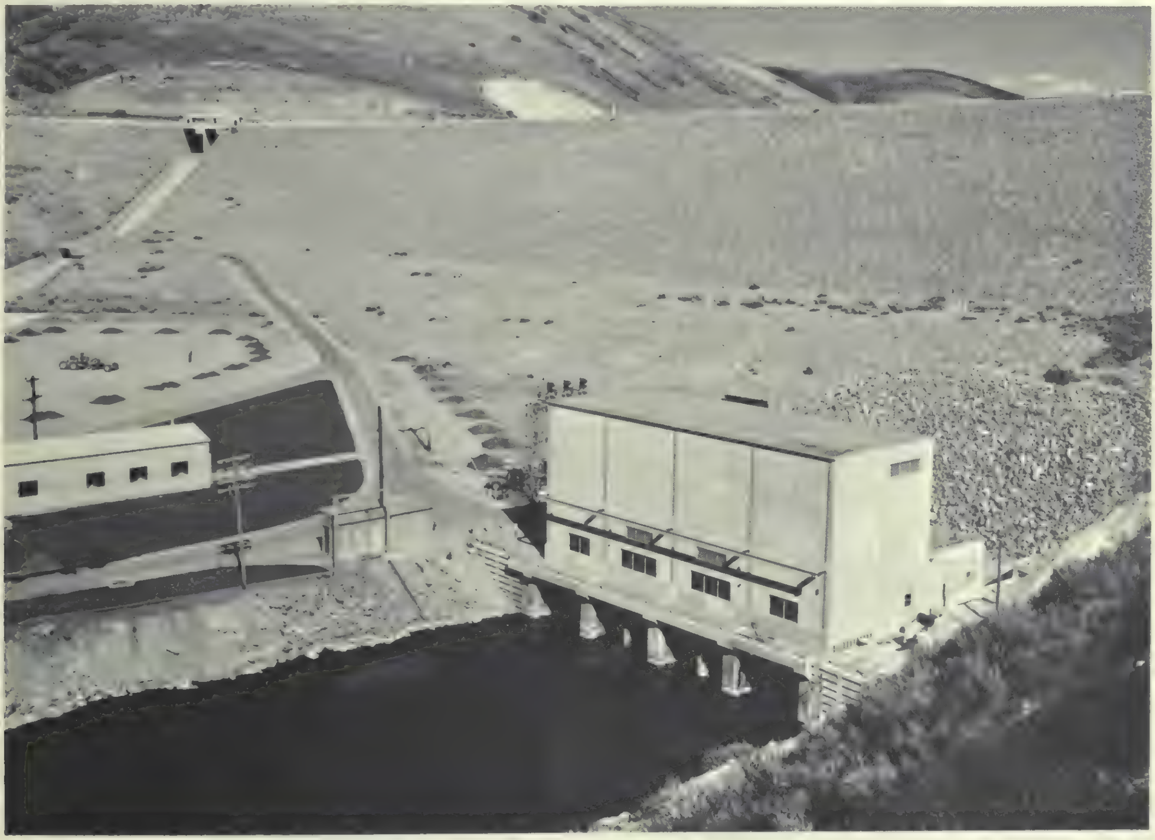
The Little Giant

The Deer Creek powerplant, on the Provo River project in Central Utah, with only 5,000 kilowatt total capacity in two equal units operating under an average head of 122 feet and discharging 566 second-feet is, in fact a little giant. Its value is measured in terms of acre-feet of water which by power exchanges with the Utah Power & Light Company permit winter flows of the Weber River normally used by the power company for generation of energy in its Weber and Riverdale plants, to be diverted for storage in the Deer Creek Reservoir.

The Deer Creek Reservoir, a feature of the Provo River Project, has an active capacity of 150,000 acre-feet providing an average annual yield of 100,000 acre-feet, which is used to irrigate 46,600 acres of land and as a supplemental supply serving 350,000 people in the Provo and Salt Lake areas.

Despite the location of the Deer Creek Reservoir on the Provo River, most of the project water supply is imported from the Weber and Duchesne Rivers. Surplus flood flows of the Weber and Duchesne Rivers are diverted through the Weber-Provo Diversion Canal and the Duchesne Tunnel. These surplus flows are not sufficient to meet the annual demand of 100,000 acre-feet from the reservoir. In order to meet the full project demands it was necessary to obtain a portion of the winter power water from the Weber River to which the Utah Power & Light Company has a prior right. In addition, exchanges of energy

View of Deer Creek Dam and Powerhouse, Provo River Project, Utah.



by PARLEY R. NEELEY, Area Engineer Spanish Fork, Utah, Development Office

for stored water are made with some Provo River flows.

The exchange of energy for water is a complex undertaking. The winter power water is that water originating above the Echo Reservoir in the Weber River which can be either diverted to the Deer Creek Reservoir through the Weber-Provo Diversion Canal or stored in Echo Reservoir between October 15 and April 15.

The diversion and storage of Weber River Power water will result in a decrease in power capacity and energy output at the Utah Power & Light Company Weber and Riverdale plants located near Ogden, Utah. The storage of Provo River power water will decrease the power capacity and energy output of the Utah Power & Light Company Olmsted plant on the Provo River. Water imported from the Weber and Duchesne Rivers when released from the Deer Creek Reservoir for summer irrigation will have the opposite effect. The decreases, and increases are to be equalized so far as possible by exchange of water, power capacity or energy production. There is some leeway in the equalization by a credit which the power company advances because of the additional energy which is generated in the Olmsted plant on the Provo River by the imported project water.

The energy production of the Deer Creek powerplant between October 15 and April 15, amounting to about 9,000,000 kilowatt-hours, is used to replace power losses resulting from the diversion and storage of power water from the Weber River and the energy production during the summer amounting to about 18,000,000 kilowatt-hours is marketed and revenues received therefrom are used for reimbursement of the construction and operating costs of the plant. Thus the Deer Creek powerplant in addition to repaying its own construction costs provides a means of turning kilowatt-hours into acre-feet of water during the winter period October 15 to April 15 and enhances the prospects of obtaining the full 100,000 acre-feet of Provo River Project water. #

Interior view of Deer Creek Powerhouse generator room. Each generator has installed capacity of 2,475 kilowatts.

WHY RECLAMATION

(Continued from p. 16)

the waterholes, they could control the range indefinitely.

Even the Sun River would get very low in the latter part of the summer, and it was not unusual to make a dam out of earthfilled burlap bags and turn the entire stream into the old valley ditch.

The fish went with it to die in the fields in the valley below.

The homesteaders who came and settled here were not very successful with their dryland farming the first few years, as there was scant rainfall. This changed, however, beginning in 1914, for this year as well as 1915 and 1916 were very favorable years, and the dryland farming boom was on. The people of the Fairfield Bench, raising good dryland crops, became more and more antagonistic towards reclamation. As a result, there was a large parade of autos, which had become quite numerous by the fall of 1916, driving down the streets of Great Falls displaying large banners which read, "We are dryland farmers from the Fairfield Bench. We don't want water." They sent one farmer to Washington to lobby for abandonment of the project. This opposition to reclamation caused the appropriations by Congress to dwindle to a low sum, causing construction to come to a halt.

The settlers were soon to pay dearly for disregarding the warnings of the natives that Montana has dry cycles as well as wet cycles. There was a very small dryland crop harvested in 1917. This was also true of 1918, with the year 1919 being the most tragic of the three, as the only vegetation that made a good growth that year was a variety of tumble weed known as Russian thistle, a hardy annual that sometimes grows to immense size and thrives very well under drought conditions.

The livestock of this part of the project started the winter of 1919 in very poor condition. The excess hay grown on the completed portion of the project, the Fort Shaw Division, was purchased early and was shipped to other areas. The Fairfield Bench farmers had been told that they could ship in hay from the Dakotas much cheaper. This proved to be very disappointing, as it was mostly sloughgrass hay, much of it harvested after the marshes had frozen over. By the time spring came in 1920, much livestock had perished.

View of Gibson Dam taken from the north end, Sun River Project.

Many farmers had lost nearly all their work horses at a time when tractors were still in an experimental stage and not very practical.

The result of all this was to start reclamation rolling again, and construction moved steadily forward until the whole project was completed.

And now what has reclamation done for this area?

The Sun River Project has been a great factor in stabilizing not only the flow of the Sun River, but the Missouri as well, when these rivers are at a low stage in the late summer. This stabilizing effect results from the return flow from irrigation at various points on about a 40-mile reach of Sun River. All of this is of benefit for public and private power development and many other users of water.

The president of the Montana Stockgrowers' Association at one of their conventions a few years ago said that these large irrigation projects were a stabilizer for the livestock industry. This is not only true in this State, but our project farmers have shipped hay to many western States, the Pacific coast, and as far east as the State of Missouri.

Many of our sportsman's groups have gone on record as being opposed to the building of the Sun Butte Dam on the North Fork of Sun River. There is no other group who has gained so much as they have from the existing reclamation reservoirs, ditches, and drains. As direct results of the development of Sun River Project (1) the Montana Fish and Game's Freezeout Lake waterfowl refuge was established; (2) the Bureau of

Sport Fisheries and Wildlife's Benton Lake Project will be furnished a water supply; (3) lush cover is provided by irrigation on Sun River Project for thousands of upland game birds, and (4) many good fishing spots have been created and sustained through the project facilities.

In addition to the drought years that I have mentioned, there were the dust bowl years in the middle thirties which affected the dryland areas in many western States, as well as our own State, where many of the dryland farmers abandoned their homes. Much of this land was later sold for taxes, some of it for as little as one dollar per acre. The farmers having irrigation were able to stay on their farms, thus adding stability to the State's population and economy.

The question is often raised: "Why increase production through reclamation when we already have crop surpluses?" About the only commodity produced on the Sun River Project in surplus is wheat. There are about 640 farms on the entire Sun River Project, with about 2,190 people living on these farms. Only about 17,000 acres, or about 19 percent of the total irrigable acreage, was used for wheat production in 1958. For many years the allotted acreage has been ridiculously low for the entire project, yet last year one man in Montana was permitted to raise 18,000 acres. Each year we see more of the virgin soil of Montana plowed and penalty wheat planted where grass had been growing. This is legal, and at the same time our farmers on the irrigated places have had their allotment cut to the point where it is no longer profitable for them to raise wheat at all.

It was man's yearning for a little piece of land that he could call his own, a desire which was denied him in many countries, that brought many to America. It has been this unfilled desire which has brought about so much bitterness and resentment throughout the ages, which has caused him in desperation to follow false prophets, usually finding in the end that they have only enslaved him into being ruled by dictators.

Teddy Roosevelt was a farsighted leader. It was his purpose to give the so-called "little people" a farm and home which brought reclamation into existence.

Reclamation-type farming has worked in the past, can work again. # # #

D. R. DAVIES
Irrigation farmer and for 34 years member of Greenfields Irrigation District board.

"GET ACQUAINTED" COPIES

If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D.C. We shall be glad to send them copies of back issues.

EFFICIENT USE OF FERTILIZER

Placing the fertilizer, particularly the phosphorus, close to or on the soil surface causes less efficient use by the young corn or soybeans. Their roots grow downward. And since phosphorus in the soil moves very slowly, if at all, the phosphorus along with the nitrogen and potassium should be placed in a zone to the side of and below the seed. Here it will intercept a portion of the young root system. Too, in dry seasons nutrients placed near the surface are more likely to be in dry soil than if placed deeper. Fertilizer in dry soil is less efficient since plant roots do not function effectively.

Some soils may fix phosphorus and potassium into less available forms. Concentrating and planting fertilizer in a narrow band reduces the contact of the phosphorus and potassium with the soil and reduces the amount of fixation.

Albert L. Connel, Champion of Washita Basin Project

Albert L. Connel, Anadarko, Okla., is president of the reactivated Oklahoma Chapter of the National Reclamation Association.

Mr. Connel, as president of the Washita Basin Improvement Association, was the driving force that brought the Washita Basin Project, Okla., through all stages of its investigations and authorization by the Congress. He kept the local interest in this project at a high pitch, and after it was approved by the President he continued to work at the congressional level for the appropriation of funds for construction.

The Fort Cobb and Foss dams and reservoirs are the principal features of the Washita Basin Project. The contract for construction of the Fort Cobb Dam was awarded in January 1958; and that dam is now nearing completion, considerably ahead of schedule. Construction of the Foss Dam and Reservoir was started with the ground-breaking ceremony in November 1958. The construction work on this dam is also well ahead of schedule.

Mr. Connell was one of four persons in the United States to receive the Department of the Interior's Conservation Service Award this year. Interior Secretary Fred A. Seaton pointed out that the award was made in recognition of Mr. Connel's outstanding contributions in the conservation of natural resources, particularly his 9-year campaign for the Washita Basin Project.

HANDBOOK FOR IRRIGATION ON WESTERN FARMS

Published by Interior and Agriculture

A bulletin on improved irrigation practices for farms in the semiarid West has been written and published jointly by the Bureau of Reclamation in the Department of the Interior and the Soil Conservation Service in the Department of Agriculture, the two agencies announced today.

The 55-page handbook, "Irrigation on Western Farms," contains data and advice on irrigated farming gathered in 15 years of coperative effort in research and testing of methods by the agencies involved and the farmers of the West.

Copies of the publication are being supplied Reclamation project managers and to SCS personnel in the locally organized and administered soil conservation districts in the Western States. It may be purchased for 40 cents from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

Commissioner of Reclamation Floyd E. Dominy said that the bulletin will help farmers to (1) know land better in preparing it for irrigation, (2) choose methods of irrigation best suited to needs, (3) know best methods of conveying water to where it is needed and how to use it efficiently, and (4) improve soil-water-plant relationship through better management for a more profitable and permanent agriculture.

Conservation of irrigation water through proper handling is becoming more and more important, D. A. Williams, Administrator of the Soil Conservation Service, said, because of the increasing demand on our water supplies and the effect of proper water use on the farmer's production costs. Wasted water often results in wasted soil through erosion, loss of fertilizer through leaching, drainage troubles and salt accumulations. #

Make Courtesy Your Code of the Road

Share the road by driving in the proper lane
Allow ample clearance when passing
Yield the right-of-way to other drivers
Give proper signals for turns and stops
Dim headlights when meeting or following cars
Respect traffic laws, signs, signals, and road marks
Adjust driving to road, traffic, and weather conditions.

Reclamation Safety Record

EVAPORATION

(Continued from p. 7)

The cost per acre-foot of water saved ranged from about $58 to $86, with an average for the entire period July 7 to October 1 of $61.21. This compares with a value of raw water in Lake Hefner of about $60 per acre-foot, as reported by the city of Oklahoma City.

The costs of hexadecanol were 73.5 percent of the total costs, and therefore any significant reduction of material costs will have an important effect on the reduction of overall costs of the future operations. Based on discussions with manufacturer's representatives, it is anticipated that material costs may be reduced as much as 50 percent of present cost.

What about the effect of hexadecanol on water quality for human consumption? In his review of the Lake Hefner results, Mr. Grady F. Mathews of the Department of Health, State of Oklahoma, tersely summarized these important conclusions:

"A review of the study data of Lake Hefner investigations resulted in the following observations on the public health aspects of the evaporation reduction work:

"1. There were no apparent toxic effects resulting from the application of hexadecanol.

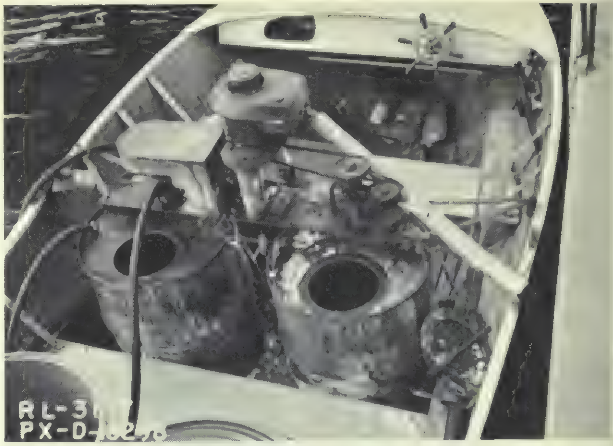
"2. There were no undesirable effects on the treatment processes of the lake water.

"3. There was no interference with the normal recreational uses of the lake.

"4. There was a large increase in the bacterial content of the lake water during the period of hexadecanol treatment, which after careful consideration, was deemed not to be significant.

"These observation support the conclusion of this department that no deleterious effects resulted from the addition of hexadecanol to the Lake Hefner water supply."

The 1958 Lake Hefner evaporation reduction investigations have shown that much has been learned about the possibilities, techniques, and methods of analysis of monomolecular layers. This information will be valuable in the ultimate development of practical methods of reduction of evaporation losses from large reservoirs. However, much work remains to be done before the full operational potentialities of this technique of evaporation reduction reaches a stage of development where specific recommendations can be made for selected reservoirs with established limits or practically attainable effectiveness based upon firm cost-benefit ratio economic data.



Mixing equipment on the boat. Clutch on right unit is uncovered for inspection.

In November and December 1959, several staff members of the Bureau's Division of Engineering Laboratories at Denver, working with the assistance of regional and Boulder Canyon Project personnel, made further tests of a monomolecular film. They applied the film to a portion of the water surface of Boulder Basin, part of Lake Mead behind Hoover Dam on the Boulder Canyon Project. The local winds at this basin have been shown by previous studies to consist of onshore, offshore flows dominated by the lake. The behavior of the film under such wind conditions was traced and recorded. The Bureau scientists, collaborating with the Salt River Project, made film behavior tests at Lake Sahuaro behind Stewart Mountain Dam on the Salt River in Arizona in December 1959. This work was in preparation for a full-scale hydrologic and economic evaluation to be performed in collaboration with several Federal and State agencies at Lake Sahuaro this summer.

As part of the Bureau's comprehensive program of the development of a practical method of reducing evaporation losses from reservoirs, various aspects of the work are being performed by the U.S. Public Health Service, Robert A. Taft Engineering Center, and negotiations are underway with several western colleges and universities for certain specialized laboratory and field investigations. Intensive studies are also being made of the surface temperature and wind conditions at a number of reservoirs in the western United States in preparation for work to be conducted. # # #

GLEN CANYON RESERVOIR NAMED LAKE POWELL

The 186-mile-long reservoir to be created on the Colorado River by the construction of Glen Canyon Dam will be known as Lake Powell, in honor of the noted explorer-geologist, Major John Wesley Powell, Secretary of the Interior Fred A. Seaton announced recently.

The name for the lake has been approved by the Board on Geographic Names on the recommendation of the Bureau of Reclamation, which is directing construction of Glen Canyon Dam and other phases of the giant Colorado River Storage Project. The recommendation was concurred in by the National Park Service.

The reservoir and contiguous lands—in northern Arizona and southern Utah—will be administered for recreation and public use by the National Park Service and will be known as the Glen Canyon National Recreation Area. The historic Glen Canyon was given its name in 1869 by Major Powell.

Secretary Seaton said the naming of the lake in honor of Major Powell is most appropriate. Major Powell led two expeditions down the Green and Colorado Rivers in 1869 and 1871–72, making the first explorations and surveys of the great river systems. He mapped and named most of the geographical features in the Glen Canyon including the canyon itself.

Construction of the dam and reservoir opens to the public an arid and once remote region of spectacular beauty, and the water playground of Lake Powell and its environs will undoubtedly become a vacation ground for millions of Americans.

In addition to the canyon, the dam will bear the name "Glen Canyon" and the steel-arch bridge (highest of its kind in the world) which spans the canyon a short distance below the damsite is known as Glen Canyon Bridge. The permanent town at the damsite has been named Page, in honor of the late John C. Page, a former Reclamation Commissioner.

Lake Powell will be one of the largest artificial lakes in the world with a capacity of approximately 28,000,000 acre-feet of water. It will have a surface area, when full, of 254 square miles, and a maximum depth, at the dam, of 580 feet. Glen Canyon Dam itself will tower 700 feet above bedrock.

Lake Powell will back the Colorado River up from Glen Canyon Dam, just below the Arizona-Utah State line, to beyond Hite, a small Utah community where there is presently a ferry crossing of the Colorado—the only crossing between Moab, Utah, and the Glen Canyon Bridge at Page, a distance of more than 250 miles.

The lake will be within the deep confines of the canyon with a long arm extending up the San Juan River and lesser waterways up the numerous side canyons which have been etched out by erosion over the centuries. #

HOLLIS A. HUNT APPOINTED AS IRRIGATION CHIEF IN REGION 4

Appointment of Hollis A. Hunt as regional supervisor of irrigation was announced by E. O. Larson, regional director, Bureau of Reclamation.

Mr. Hunt will be in charge of activities related to the operation and maintenance of the Bureau's Region 4 irrigation projects. Included as part of his responsibilities will also be land transactions, repayment contract negotiations and recreation and fish and wildlife matters.

He previously held several positions with the Bureau of Reclamation in the Salt Lake area from 1946 to 1951. He supervised field work on the Weber Basin Project, later establishing the Ogden office for Weber Basin.

Following a period of service as engineering assistant to the regional director, Mr. Hunt was appointed to open the Lahontan Basin Projects office at Carson City, Nev., in 1951. He has served as projects manager of the Carson City office for the past eight years.

After he was garduated from the University of Arizona in 1936 as a civil engineer, he joined the Bureau on the Gila Project, Yuma, Ariz. He entered the U.S. Army in 1941 and was discharged in 1946 with the rank of colonel.

He and his wife, the former Roberta Sainburg, of Vernal, will reside at 2200 Sunnybrook Way (4020 South).

It takes only fifty years to wash down seven inches of topsoil that has taken thousands of years to build up—*Twentieth Century Fund.*

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award Date	Description of Work or Material	Contractor's Name and Address	Contract Amount
DC-5197	Washoe, Nev.-Calif	Dec. 8	Construction of Prosser Creek Dam	R. A. Heintz Construction Co., Portland, Oreg.	$2,181,324
DC-5218	Collbran, Colo	Dec. 9	Construction of earthwork and structures for South-side canal, Sta. 1146+49 to end, utilizing pretensioned concrete pipe in siphon barrels, schedules 1 and 3.	A. S. Horner Construction Co., Denver, Colo.	585,594
DS-5224	do	Nov. 6	One 12,000-hp and one 6,800-hp, horizontal-shaft, hydraulic turbine; 2 governors; and 2 shutoff valves for Upper and Lower Molina powerplants.	Allis-Chalmers Mfg. Co., Denver, Colo.	232,921
DS-5225	do	Nov. 6	One 9,600-kva and one 5,400-kva generator for Upper and Lower Molina powerplants.	Carrier Corp., Elliott Company Division, Ridgway, Pa.	264,825
DC-5227	Missouri River Basin, Nebr.-Kans.	Oct. 29	Construction of earthwork and structures, including pipe siphon, for White Rock extension canal, Sta. 307+90.4AH to end; and laterals and drains, schedules 1, 3, and 4.	Peter Kiewit Sons' Co., Wichita, Kans.	699,580
DC-5232	Crooked River, Oreg	Nov. 19	Construction of earthwork, structures, and surfacing for relocation of Oregon State Highway No. 27, Prineville Reservoir.	Keystone Construction Co., Inc., and Associates, Prineville, Oreg.	164,621
DC-5235	Weber Basin, Utah	Nov. 10	Construction of earthwork, pipelines, and structures for Woods Cross lateral system, part 1.	Hansen-Niederhauser, Inc., Salt Lake City, Utah.	312,382
DC-5240	Boulder Canyon, Ariz.-Calif.-Nev.	Dec. 3	Installation of equipment and reconstruction of transformer circuit for unit N-8, Hoover powerplant and switchyards.	Gunther and Shirley Co. and E. V. Lane Corp., Sherman Oaks, Calif.	767,976
DC-5241	Rogue River Basin, Oreg	Dec. 21	Construction of earthwork and structures, including 12 siphons, wasteways, and retaining walls, for Ashland lateral rehabilitation, utilizing concrete cylinder pipe (pretensioned) for the siphon barrels, schedule 1.	Arthur R. Sime and Glen A. Pegram, Kennewick, Wash.	210,930
DC-5242	Missouri River Basin, Kans.	Dec. 1	Construction of earthwork and structures for Osborne canal, Sta. 1069+64.4 to 1719+00, and laterals and drains.	Bushman Construction Co., St. Joseph, Mo.	604,785
DC-5245	Lower Rio Grande Rehabilitation, N. Mex.	Dec. 2	Clearing, and construction of earthwork, concrete lining, and structures for rehabilitation of H lateral, Sta. 1+10 to 276+96.	do	375,808
DC-5251	Central Valley, Calif	Dec. 22	Construction of earthwork, pipelines, and structures for lateral 99.4 and sublaterals, Tea Pot Dome Water District, Friant-Kern canal distribution system.	Cen-Vi-Ro Pipe Corp., Shafter, Calif.	1,208,662
117C-567	Columbia Basin, Wash	Nov. 25	Construction of asphaltic membrane lining for fifth section of West canal, schedule 1.	E-W Construction Co., Cresswell, Oreg.	120,132
117C-567	do	Oct. 30	Construction of blended earth lining for Royal Branch canal, schedule 2.	Cherf Brothers, Inc., and Sandkay Contractors, Inc., Ephrata, Wash.	207,256

U.S. GOVERNMENT PRINTING OFFICE: 1960 O—534175

Construction and Materials for Which Bids Will Be Requested Through March 1960*

Project	Description of Work or Material
Boulder Canyon, Ariz., Calif., Nev.	One 3-phase, 105,000-kva, 15,750-delta/230,000 wye volts, 60-cycle, class FOW, outdoor-type power transformer for Hoover powerplant, unit N-8. Estimated weight: 356,000 pounds.
Central Valley, Calif.	Constructing two 18-foot 6-inch-diameter tunnels, one 4,500 feet long and the other about 8,300 feet long, including a gate shaft and a vertical shaft and open-basin-type surge tank, and constructing a 17-foot-diameter steel-lined concrete or platesteel siphon connecting the 2 tunnels. Spring Creek power conduit, near Redding.
Do.	Two 200-rpm, vertical-shaft, Francis-type hydraulic turbines, including 2 interchangeable runners for each turbine, 1 runner rated 85,000 hp at 426-foot head and the other rated 70,000 hp at 334-foot head, for Trinity powerplant.
Do.	Two 93,500-hp, 225-rpm, 514-foot-head, vertical-shaft, Francis-type hydraulic turbines for Clear Creek powerplant.
Collbran, Colorado	Constructing 2 reinforced concrete overflow weir diversion structures on Leon Creek and on Park Creek, and about 3.2 miles of earth canal to Vega reservoir. Near Collbran.
Do.	One 3-phase- 6,000-kva, 4.16-delta-69 grd wye/39.-88-kv, class OA, outdoor power transformer for Lower Molina switchyard; and one 3-phase, 10,500-kva, 4.16-delta-69 grd wye/39.88-kv, class OA, outdoor power transformer for Upper Molina switchyard.
Colorado River Storage, Ariz.	Four 96-inch ring-follower gates including hydraulic hoists for Glen Canyon dam. Estimated weight: 560,000 pounds.
Colorado River Storage, N. Mex.	Steel outlet pipe, 30 and 110 inches in diameter; drain and filling lines with valves, 6 inches in diameter; steel walkway; and anchor bolts for Navajo dam. Estimated weight: 1,540,000 pounds.
Columbia Basin, Wash.	Constructing the indoor-type Frenchman Hills pumping plant with 3 pumping units of 164-cfs total capacity, 3 of which are to be transferred from Pasco pumping plant, and provision for 6 future pumping units with additional capacity of 216 cfs, constructing a reinforced concrete substructure and a structural steel frame superstructure with metal siding and roof decking, and installing an indoor traveling crane. Constructing the indoor-type Hope Valley pumping plant with 3 pumping units of 60-cfs total capacity, a reinforced concrete sump substructure and a structural steel frame superstructure with metal siding and roof decking, and installing an indoor traveling crane. Near Quincy.
Do.	Earthwork and structures for about 19 miles of 10- to 2-foot bottom width concrete-lined laterals, about 7 miles of 8- to 2-foot bottom width unlined laterals and wasteways, and about 21 miles of 8- to 3-foot bottom width earthlined laterals. Block 80, west of Warden.
Gila, Ariz.	Earthwork and structures for about 28 miles of 2-foot bottom width unreinforced concrete-lined open channel Wellton-Mohawk drain. Near Yuma.
Lower Rio Grande Rehabilitation, Tex.	Rehabilitating about 9 miles of lateral consisting of reshaping the prism and banks and constructing unreinforced concrete lining with bottom widths of 5 and 3 feet in the new section. Work will also include constructing timber slide-gate checks, concrete bridge, turnouts, drainage culverts, and road crossings. "C" and "G" laterals, near Mercedes.
Middle Rio Grande, N. Mex.	Clearing, cleaning, and shaping about 7.8 miles of open-ditch laterals and replacing structures. Albuquerque units 4 and 5.
Do.	Clearing, cleaning, and shaping about 22.9 miles of open-ditch laterals and replacing structures. Belen units 7, 8, and 15.
MRBP, Colo.-Wyo.	Surveying, furnishing, and constructing a complete microwave radio communications system with about 6 telephone channels and 15 telemeter channels. System to have terminals at the Flatiron dispatch office, near Loveland,
MRBP, Colo.-Wyo—Continued	and the Cheyenne substation, near Cheyenne, with intermediate relay stations as required. Contractor to maintain the system for 1 year after construction is completed.
MRBP, Kans.	Earthwork and structures for 6.9 miles of canal, 4.8 miles of open laterals, and one 51-cfs pumping plant. Courtland No. 1 canal, north of Courtland.
MRBP, Nebr.	Constructing the 3,000,000-cubic-yard Red Willow earthfill dam, 126 feet high and 3,150 feet long, and appurtenant structures consisting of a conduit type outlet works and a spillway. On Red Willow Creek, about 10 miles north of McCook.
Do.	Earthwork and structures for about 15 miles of 2- to 5-foot bottom width canal, about 21.5 miles of 6- to 3-foot bottom width laterals and wasteways, and about 1.7 miles of 15- to 8-foot bottom width drains. Culbertson Extension canal (Sta. 1719+00 to 2571+36). Near McCook.
Do.	One 3-phase, 10,000-kva, 115-6.9-34.5-kv, 60-cycle, class OA, outdoor power transformer for Kimball substation.
MRBP, N. Dak.	Clearing right-of-way, furnishing and installing fence gates, constructing footings, and furnishing and erecting steel towers for about 83 miles of 230-kv, single-circuit Jamestown-Fargo No. 2 transmission line.
Do.	Furnishing and constructing 110 miles of 115-kv wood-pole transmission line with a short section of steel tower construction. Garrison-Minot-Rugby transmission line between Riverdale, Minot, and Rugby.
Do.	Stage 03 additions to the Edgeley substation will consist of constructing concrete foundations and installing one Government-furnished 69-kv circuit breaker and associated electrical equipment. Stage 02 additions to the Carrington substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing one 46-kv circuit breaker and associated electrical equipment, major items of which will be Government-furnished.
MRBP, S. Dak.	Constructing the Fort Thompson substation, stage 01, will consist of grading the area, constructing concrete foundations, and a 100- by 40-foot control building, furnishing and erecting steel structures, and installing twelve 230-kv circuit breakers, two 69-kv circuit breakers, a 3-phase, 20,000-kva, 230- to 69-kv autotransformer, a station service unit substation, and associated electrical switching and control equipment, major items of which will be Government furnished.
Do.	Clearing right-of-way, furnishing and installing fence gates, constructing footings, and furnishing and erecting steel towers for about 57 miles of 230-kv double-circuit Oahe-Fort Thompson No. 3 transmission line (stage 01). From Oahe switchyard north of Pierre, to Fort Thompson substation about 50 miles southeast of Pierre.
San Angelo, Tex.	Constructing the 21,000,000-cubic-yard Twin Buttes earthfill dam, 134 feet high and 8 miles long, and appurtenant structures. On the Middle and South Concho Rivers and Spring Creek, about 9 miles southwest of San Angelo.
Washita Basin, Okla.	Constructing about 55 miles of 18- to 42-inch-diameter pipelines for hydrostatic heads of from 50 to 200 feet and appurtenant control structures. Foss aqueduct, near Clinton.
Weber Basin, Utah	Constructing about 8.5 miles of pipe distribution system. Pipe sizes are to be 4- to 24-inch-diameter for heads of from 25 feet to 300 feet and may be concrete pressure pipe, asbestos-cement, pretensioned, or steel pipe. North Davis lateral system, near Ogden.
Yakima, Wash.	Replacing wooden flumes 2, 3, and 4 with 72-inch, inside diameter, concrete pipe siphons. Tieton Division, about 13 miles west of Yakima.

*Subject to change.

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REGIONAL OFFICES

REGION 1: Harold T. Nelson, Regional Director, Box 937, Reclamation Building, Fairgrounds, Boise, Idaho.
REGION 2: Hugh P. Dugan, Regional Director, Box 2511, Fulton and Marconi Avenues, Sacramento 11, Calif.
REGION 3: Regional Director, Administration Building, Boulder City, Nev.
REGION 4: E. O. Larson, Regional Director, 32 Exchange Place, P.O. Box 360, Salt Lake City 10, Utah.
REGION 5: Leon W. Hill, Regional Director, P.O. Box 1609, Old Post Office Building, 7th and Taylor, Amarillo, Tex.
REGION 6: Frank M. Clinton, Regional Director, 7th and Central, P.O. Box 2553, Billings, Mont.
REGION 7: John N. Spencer, Regional Director, Building 46, Denver Federal Center, Denver, Colo.

The Reclamation Era

MAY 1960

IN THIS ISSUE:

Land Leveling in the Casa Grande Valley
Key to the Trinity

Official Publication of the Bureau of Reclamation

The Reclamation Era

MAY 1960 **VOLUME 46, NO. 2**

In this issue . . .

J. J. McCARTHY, Editor

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Flat leveling in benches, 3½-foot cuts on high side, 3½-foot fills on low side. (Soil Conservation Service photos.)

LAND LEVELING in the CASA GRANDE VALLEY

Level irrigation in the semiarid regions of the United States is not something new. During the last 5 years a number of stories have been published in the various agricultural and construction magazines on the subject. Agricultural engineers have studied the practice and USDA's Agricultural Research Service has found that the resulting high efficiency of water application and distribution makes level irrigation desirable where water is scarce.

In the West Coolidge and Florence-Coolidge Soil Conservation Districts in the Casa Grande Valley of Pinal County, Ariz., there are two other factors in addition to a short water supply that have influenced farmers in this type of land shaping. Those that have saline and/or alkaline lands need flat land in their leaching program of soil reclamation; and those farms that receive surface waters through the San Carlos irrigation project need a system that will provide for water penetration when the water from the project contains a very high percentage of fine silts. These waters normally follow the runoff from summer rains in the upper part of the San Pedro River. One irrigation with this fine silty water is all it takes to seal the surface soils to the extent that it is practically impossible to get a sufficient irrigation on any kind of soil. Therefore regardless of whether it is a short water supply containing silt, or a salt problem, level land is the answer as the water applied remains on the surface of the soil at a uniform depth until it penetrates into the soil or is lost by evaporation.

In an area of short water supply for irrigation, the increased efficiency with level land provides for a uniform distribution of water and depth of wetting. Those over and under irrigation areas

by NORRIS A. MATHEY, Work Unit Conservationist
Soil Conservation Service, Coolidge, Ariz.

Field flat leveled in direction of irrigation with maximum sidefall 0.1 foot per 100 feet of field width.

normal to fields that have a grade in the direction of irrigation are eliminated.

In this area flat leveled fields have proven a saving of 25 to 33 percent in the amount of irrigation water required to grow a crop. This means more than just a saving in cost of water. It means that the farmer with level land can farm more acres than he could under the old system of irrigation on a graded field, since most farms in the area have more land than their water supply will adequately irrigate.

If flat leveling is to be successful, the soils of the field must be similar so the water intake will be about the same over the field; the length of the irrigation run must be so designed that the stream of water started on an irrigation set will reach the end of the field within a specified time. This applies to both border and row crops; the width of irrigation borders or basins being dependent on the head of water available. The field lengths may vary from 440 feet on sandy loams or coarser textured soils to a maximum of 880 feet on the soils of finer textures. In this part of Arizona where alfalfa is grown during the summer months, dead level land is not recommended for soils having a slow water intake rate since it is quite impossible to eliminate small depressions during seedbed preparation. These low spots result in sun scald of the crop.

Whether or not labor costs are reduced in farming flat leveled land is debatable. With good water delivery systems, such as concrete-lined irrigation ditches with outlet pipes equipped with watertight gates, the only labor required is the opening and closing of the gates. Adjustments in stream size are not needed. These timesaving factors are offset by more ditches, more turn rows, shorter fields, and a loss of the amount of ground required for extra ditches and turn rows.

The economy of this type of farming has been proven. The initial costs are high, with the dirt moving amounting to as much as 1,200 cubic yards per acre; but the results are also high. J. J. Woodruff of the West Coolidge SCD, Arizona, stated that the amount of water saved on his 1957 crop on a quarter section of land that he flat leveled in the fall of 1956 paid for the concrete lining of his irrigation ditches, and the additional crop production nearly paid for the land leveling. Another big believer in flat leveling is H. L. Holland, who has farms in both the West Coolidge and the Florence-Coolidge Soil Conservation Districts, Arizona. Holland was the first of the farmers in this area to go to flat fields. He started his flat leveling program in 1954, and now has flat fields with sandy loam soils, loams, and heavy or very fine textured clay loams. He is still at it and plans to eventually have all of his irrigated land as flat as a floor. ###

The goal is reached with a uniform crop over the field. (Note silt crusts in foreground.)

.... old but no longer tired

A 40-year-old irrigation system may become a little tired and worn, and a facelifting gives it new vigor. For the water users on the North Platte project in Wyoming and Nebraska, the facelifting is paying off not just in appearances, but in water saved and land reclaimed.

Theirs is a big and continuing program, suitable to a 225,000-acre project. Ten years and $3.9 million have been invested in it thus far, and it's nearing completion of presently scheduled work. Even incomplete, the program is conserving 28,000 acre-feet of water a year.

"Rehabilitation and Betterment" is the self-identifying title of this form of Bureau of Reclamation activity, and the North Platte project was one of its first two applications. While public attention focused on the more spectacular Bureau dams and powerplants, the North Platte's R. & B. program quietly went about getting the substantial job done of placing:

1⅓ million square yards of asphaltic membrane canal lining;

5 miles of concrete canal lining;

30 miles of concrete irrigation pipelines: and

6,700 linear feet of steel pipelines.

These are the works. The benefits accruing from them can be only partly measured and have only begun to make their payoff. This much is known: In the Goshen Irrigation District, agricultural production has increased by 861 acres of seeped land completely rehabilitated, another 1,844 acres partially benefited, and 14,800 acre-feet of irrigation water saved annually. In the Gering and Fort Laramie Irrigation Districts, 787 acres were completely rehabilitated, 339 acres were partially benefited, and the water savings are 13,200 acre-feet annually. Operation and maintenance costs have been substantially reduced.

by CHARLES RADER, Construction Engineer
Bureau of Reclamation, Torrington, Wyo.

Lining canals and laterals arrests the progressive losses of land because of seepage. A chain reaction follows. When land formerly in partial or total disuse is placed in full production . . . when unsightly laterals and drains are filled . . . when weed patches are removed—easier farming operations result and land values in the immediate area are enhanced. All lands in the district enjoy some increase in value, farmers are more prosperous, and business in the towns increases. There are even esthetic improvements.

Construction of canals on the North Platte project began in 1905, and by 1925 most of these and their laterals were in service. (Today there are 340 miles of main canals and nearly 1,300 miles of laterals.) Conditions inevitably developed through the years calling for repair. Seepage caused losses of water, damage to farmlands, and drainage problems. Many structures needed repair or replacement.

During World War II, maintenance work was limited. To catch up with the backlog of needed corrections and improvements, in 1949 the Goshen Irrigation District and the Gering and Fort

Slip-form is used in placing cast-in-place concrete pipe, Fort Laramie lateral, Goshen Irrigation District.

Laramie Irrigation District entered into repayment contracts with the Federal Government for R. & B. work. Repayment will be made under the 40-year contracts—$2 million for Goshen and $1½ million for Gering-Fort Laramie.

The Bureau established offices in Torrington, Wyo., in 1948 under a construction engineer. R. & B. for the Goshen and the Gering-Fort Laramie began in 1949. Initially, the work was done through Federal contracts with contruction firms. Later, a new law made it possible for the irrigation districts to do their own R. & B. work under contracts between the districts and the United States.

Most of the work, especially on laterals, has been accomplished by irrigation district forces; there has been some use of subcontracts. The majority of the construction has been on a local level, resulting in employment of local men and in business for local concerns.

The first phase was to select reaches of the Fort Laramie Canal and the laterals that most needed rehabilitation. The Bureau's construction engineer cooperated with the superintendents and the boards of the districts in choosing yearly programs.

The Fort Laramie Canal, constructed between 1915 and 1925, has a capacity of 1,500 cubic feet per second and served both districts along the south side of the North Platte River. Its rehabilitation involved construction of 20.6 miles of asphaltic membrane lining. The catalytically blown asphalt was developed by the Bureau, the Asphalt Institute, and oil companies to produce the material especially suited to this type of work. Drainage inlet structures developed by the Bureau were built as needed.

In the Goshen Irrigation District, 23 miles of the lateral system have been lined with the asphaltic membrane, and 2.2 miles with concrete placed by the slip-form method, first to a thickness of 2 inches and later to a more satisfactory thickness of 4 inches. Sixteen miles of concrete irrigation pipeline, from 12 to 42 inches, have been installed in the Goshen. Standard division boxes were used for turnouts.

In the Gering and Fort Laramie Irrigation District, 14.1 miles of concrete pipelines, 2.6 miles of

Goshen District forces digging trench with backhoe and laying pipe with truck crane.

Application of asphalt lining, Cherry Creek lateral, on North Platte project. (Photos by A. D. Kalal, Bureau of Reclamation, Region 7.)

asphalt membrane lining, 2.7 miles of slip-form lining, and three steel pipelines have been built. Where pipelines were installed, the estimated saving per mile in operatión and maintenance costs is $180 a year.

In 1958 the Goshen District entered into a second repayment contract for additional rehabilitation work, not to exceed $2 million. This district recently completed a concrete pipe manufacturing plant at Torrington. Construction of pipelines using this locally manufactured concrete pipe is now in progress on the Goshen laterals. The Government loans make it possible for irrigation districts to do vitally needed construction work, which otherwise would be prohibited because of high cost, interest, and shorter repayment periods.

Location of a Bureau construction engineer at Torrington has been a convenience utilized to carry out construction activities undertaken in other Bureau of Reclamation programs. Including these, the office has supervised construction of 43 miscellaneous structures, as well as the installation of demonstrational asphaltic membrane lining and concrete lining in the Northport and Pathfinder Irrigation Districts—the other two districts in the project.

The miscellaneous structures include a retention dam, drop structures, transformers and condensers installed at power substations, wasteway repairs, a 390-foot, 3-barrel concrete siphon with transitions, diversion dams, bridges, Parshall flumes, and numerous other winds of work. ###

CREDIT

The article "Salt River Sports" which appeared in the February issue of the *Reclamation Era* was reprinted from the *Current News*, the Salt River Project employees publication in Phoenix, Ariz.

A credit line for the *Current News*, edited by Mr. James V. Stone, should have appeared in the *Era* at the time of publication of the "Sports" article.

We regret this oversight.—*Ed.*

CHANGES IN BUREAU OF RECLAMATION REGIONAL DIRECTORS ANNOUNCED


E. O. LARSON


F. M. CLINTON


BRUCE JOHNSON


A. B. WEST


W. E. RAWLINGS

Three changes in Regional Directors of the Bureau of Reclamation were announced recently. The changes were made necessary by the retirement of E. O. Larson, longtime Director of Region 4 with headquarters at Salt Lake City, Utah, and the transfer of Regional Director W. H. Taylor, Region 3, Boulder City, Nev., to become Chief of the Division of Power Operations and General Engineering in the Commissioner's Denver office. Mr. Larson retired March 1 to accept a position with an outside firm as an engineering consultant.

The new appointments are:

F. M. Clinton, Director of Region 6 with headquarters at Billings, Mont., to Director of Region 4, succeeding Mr. Larson.

Bruce Johnson, Manager of the Missouri-Souris Projects Office at Bismarck, N. Dak., to Director of Region 6, succeeding Mr. Clinton.

A. B. West, Regional Supervisor of Irrigation, Boulder City, Nev., succeeding Mr. Taylor.

The appointments were made by Commissioner of Reclamation Floyd E. Dominy with Secretary of Interior Fred A. Seaton's concurrence. Also announced were two other major field assignments:

W. E. Rawlings, Supervisor of Irrigation in Region 6 at Billings, to be Manager of the Columbia Basin Reclamation project at Ephrata, Wash., succeeding P. R. Nalder who recently accepted a foreign assignment with the Bureau in Afghanistan.

All of the appointments were effective March 1.

MR. LARSON'S retirement followed continuous service with the Bureau of Reclamation since June 1923, shortly after receiving an M.S. degree in civil engineering from Utah State University at Logan. He had previously received a B.S. in irrigation and drainage engineering from the same school. He is a native of Santaquin, Utah.

He has worked on virtually every Reclamation project undertaken by the Bureau of Reclamation in Utah and, since 1943, has been Director of

Region 4, which comprises most of Utah and portions of Colorado, Wyoming, Idaho, Nevada, New Mexico, and Arizona. Two years of other Federal service preceded his work with the Bureau of Reclamation.

His work in recent years has been primarily devoted to the monumental Colorado River Storage Project which was authorized by the Congress in 1956 and which is now under construction. He also served as chairman of the Department of the Interior Southwest field committee for a number of years. He advised Commissioner Dominy that after nearly 39 years of Federal service he desires to slow down his work pace somewhat. He plans to do some work as a consulting engineer. He has received numerous honors for his career of nearly 39 years in Federal service, including a merit citation from the National Civil Service League and the Distinguished Service Award from the Department of the Interior. Only last year he received Utah's Distinguished Service Award as the outstanding Federal employee in the State.

MR. CLINTON brings to the big construction and operating program in Region 4 a wealth of Reclamation experience accumulated in the Salt River, Columbia, and Missouri River Basins. Under construction in Region 4 are three major units of the Colorado River Storage Project and five participating projects, as well as several other projects.

A native of Bisbee, Ariz., and a graduate in civil engineering from the University of Arizona, he went to work for the Bureau of Reclamation as an inspector on the Bartlett Dam of the Salt River Project in 1937. He worked on investigations in the Big Horn basin in Wyoming, then spent 2 years in Idaho Falls, Idaho, working out the complicated water distribution plan for Palisades Dam on the Snake River. He was in the Region 1 office at Boise, Idaho, from November 1944 to December 1953, when he was named Director of Region 6. While in Boise he was first assistant project planning engineer and later Assistant Regional Director.

MR. JOHNSON is a native of Grand Forks, N. Dak., and has been with the Bureau of Reclamation since September 1940, having been continuously employed in Bismarck, N. Dak. A graduate in civil engineering from the University of North Dakota, he has participated in planning and construction activities in that State, particularly those associated with Bureau of Reclamation responsibilities in development of the Missouri River Basin project. He has been directly in charge of investigations and preparation of the report on the Garrison diversion unit of the Missouri River Basin project, which was recently completed. As Regional Director, he will have a major responsibility in carrying on this and other projects in the region which also comprises parts of Montana, South Dakota, and Wyoming.

MR. WEST joined the Bureau of Reclamation in 1941. After serving for 3 years in the Washington office, he was transferred to Boulder City in August 1944 as assistant to the Regional Director. In December 1945 he became regional operations and maintenance supervisor (later designated regional supervisor of irrigation), a position he has held until his present appointment.

Before joining the Bureau of Reclamation, Mr. West was empolyed for several years by the Department of Agriculture, serving as a soil conservationist and agricultural economist in Albuquerque, Denver, and Berkeley.

Mr. West was graduated from Hamline University, St. Paul, Minn., in 1932 with a B.A. degree in business administration. He also did graduate work at the University of Minnesota.

MR. RAWLINGS, in undertaking the position of Columbia Basin Project Manager, moves into an area where operating management is becoming the prime requisite as the project moves into an operating phase. There are now facilities completed for the irrigation of nearly 425,000 acres of land on the project. Mr. Rawlings is a native of Sheridan, Ind., and a graduate in agriculture from Purdue University and was associated with the Agricultural Extension Service and Bureau of Agricultural Economics of the Department of Agriculture in Indiana and Idaho from 1928 to 1942.

# # #

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DO-IT-YOURSELF

PIPE WEED DEFLECTOR

The weed deflector shown in the photograph below was constructed at the request of and in accordance with plans prepared by Mr. Donald T. Mutch, Watermaster, West Branch of the North Side Irrigation Field Division, Minidoka Project, Idaho. The deflector is quite successful in keeping weeds and other floating debris from entering the farm turnouts.

The deflector is constructed of pipe throughout. Two large-diameter pipes embedded in concrete in the side slopes of the canal serve as support for the five horizontal pipe components shown. The large vertical pipes are drilled to accommodate the larger horizontal pipe, which is welded to the vertical support for added structural rigidity.

The smaller horizontal pipe components are of such diameter that they fit into the larger horizontal pipe. The smaller pipe must be of such length that it can be telescoped outwardly into the canal as required to provide for adjustment and the best possible setting at a given location for deflecting the weeds and other trash from the turnout inlet structure.

DRAIN OUTLET RODENT CONTROL SCREEN

A wire screen is being used on the outlet end of closed drains on Riverton Project, Wyoming, to prevent access to the drain line by rodents. As shown below, the screen is constructed of standard 1- by 2-inch, 14-gage, electric welded wire fencing material and is pushed into the end of the corrugated metal pipe drain outlets. The screen has been very useful and satisfactory, and its publication was at the suggestion of D. B. Woltersdorf, Chief, Regional Drainage Branch, Billings, Mont.

PREVENTING MILE POST DEFACEMENT by BIRDS

The farm turnout headgates along the Delta-Mendota Canal, Central Valley project, California, are identified for operating purposes by posts of sawed timber, painted white, and bearing on two or more sides, stenciled numbers, in black,

(Continued on page 54)

what has been done about salt cedar at Caballo Reservoir

by T. H. MOSER, Assistant Project Manager, Rio Grande Project, El Paso, Tex.

A 2-year program of saltcedar clearing and control has recently been completed in the upper portion of the Caballo Reservoir area, near Truth or Consequences, N. Mex. Nearly 5,500 acres of growth has been cleared and controlled under the program. This work was accomplished under a cooperative agreement between the Bureau of Reclamation and the State of New Mexico, with each agency furnishing equipment and funds. Bureau maintenance forces from Elephant Butte Dam performed the work.

The need for a saltcedar control program at Caballo Reservoir became increasingly evident as the density and area of infestation increased. Like a great many areas in the Southwest, the infestation of saltcedar at Caballo Reservoir has increased considerably in the last few years, but the increase was even more pronounced during the period from 1950 to 1957. During this time the storage in the reservoir was at a low elevation because of a severe water shortage. Storage in this reservoir is controlled by releases from Elephant Butte Dam, 25 miles upstream on the Rio Grande.

During the normal pattern of operation, Caballo Reservoir covers an area of about 10,000 acres at the annual high-water stage prior to releasing water for irrigation of Rio Grande Project land below Caballo. Because of the 8-year drought, the average annual high-water level covered less than 5,000 acres. This allowed the saltcedar infestation to spread from about 3,000 acres in 1950 to about 9,000 acres at the beginning of the clearing program in 1957. Some plants were at least 35 feet tall and much of the infested area approached 100 percent density.

In considering the area to be cleared, it was

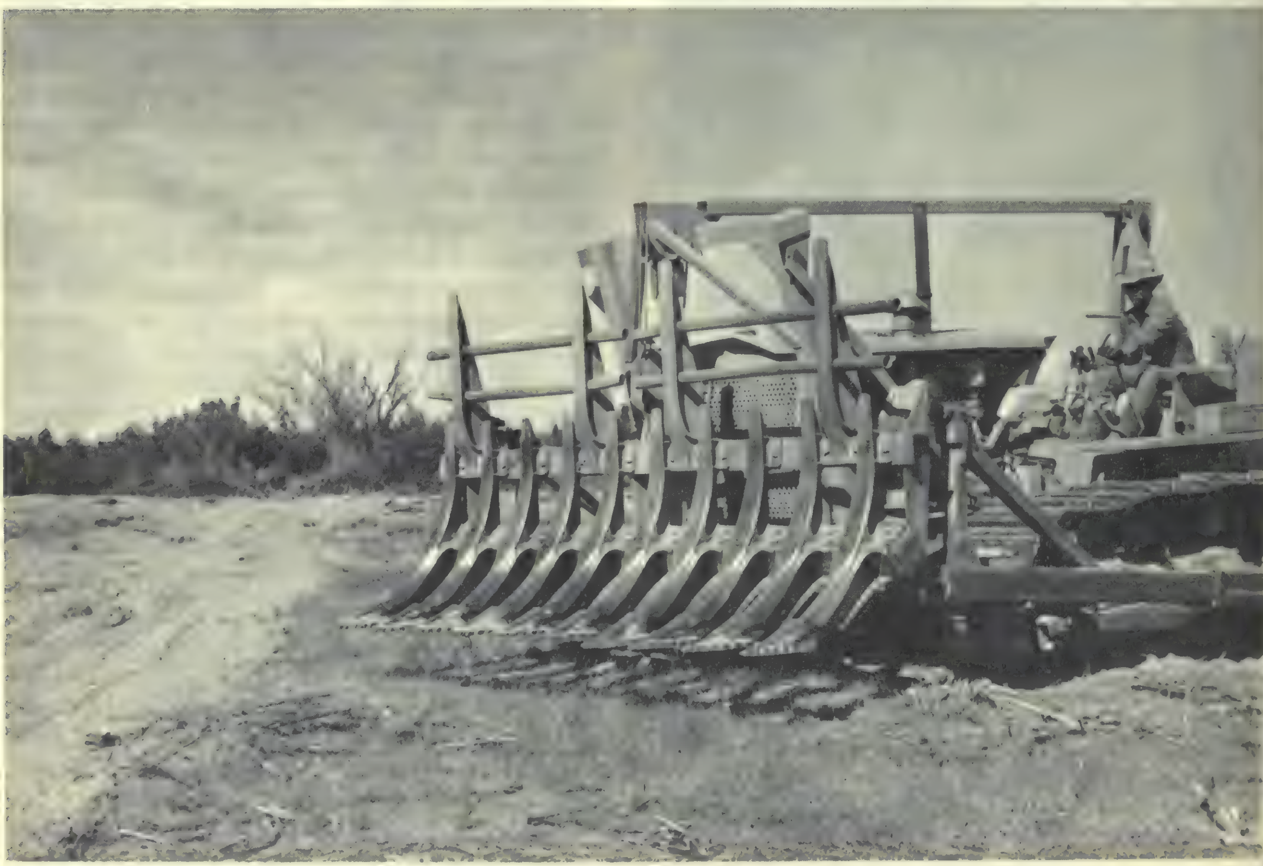
hoped that sufficient storage water could be available in future years to return to the normal pattern of storage in the reservoir, thereby inundating all the area below the uppermost 5,500 acres for a period of time every year. Therefore, the program was designed to clear and control the growth on only the uppermost 5,500 acres.

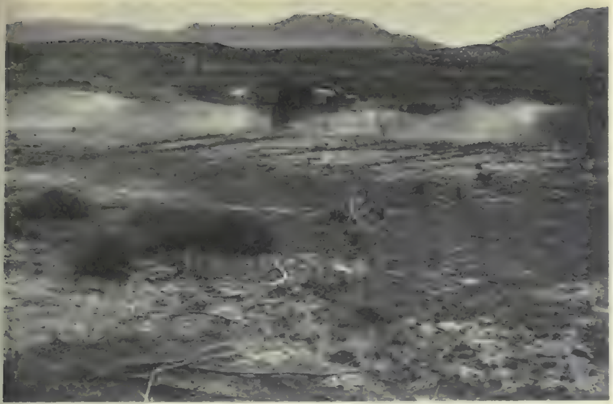
With increased inflow into Elephant Butte Reservoir during the latter part of 1957 and in 1958, storage in Caballo reached a level that covered all the remaining growth not programed for clearing for a period of time each of the last 2 years. This inundation retarded the growth and killed a portion of it. Repeated inundations, if sufficient storage water is available, may provide sufficient control for this area.

The cost of clearing and controlling the uppermost 5,500 acres of the 11,613-acre reservoir was justified on the basis of an estimated annual saving of water of 14,000 acre-feet. Saltcedars consume tremendous quantities of water—more than any other common type of phreatophyte. The estimated savings of water was based on a semidetailed survey of the types and density of the plants in the area and the extent of the infestation. The consumptive use by this vegetation was computed from the methods derived by the U.S. Geological Survey in the 1943–44 investigations in the Safford Valley, Ariz., as recorded in Water Supply Paper No. 1103. Based on detailed observations of the groundwater level in 63 measuring wells throughout the entire reservoir area over the last 2-year period with data being collected both before and after clearing, the New Mexico State Engineer's office is currently in the process of recomputing the estimated water salvage resulting from the clearing and control work.

Previous attempts at saltcedar control in this area were without substantial success. Aerial spraying of 1,800 acres of the area was tried on four occasions between 1951 and 1956, using a spray consisting of a solution of sodium salts of 2, 4-D, oil, and water. Each time defoliation and some topkill occurred, but practically no eradication of mature plants resulted. Therefore, this method of control for adult plants in this area was

Root rake, showing serrated shoes attached to the teeth. These prevent brush from logging between teeth of root rake.





John Bean sprayer pulled by State tractor, spraying regrowth. Sprayer equipped with 600-gallon tank.

ruled out. Instead it was decided to clear the area by mechanical means and to maintain it by controlling the regrowth after the initial clearing.

Clearing the 5,500 acres was accomplished by the use of two 84-inch-diameter rotary cutters and two large crawler tractors equipped with root rakes. Shoes with serrated edges were attached to the ends of the teeth of the root rakes to prevent roots from wedging between the teeth. The rotary cutters operated in areas where the growth was small—normally less than 2 inches in diameter—and the root rakes cleared the larger growth, literally pulling the trees out by the roots. The cleared trees were then stacked and burned so they could not float to the lower reservoir during high-water stages and be lodged against the intake tower of the dam. After burning, the piles of brush were restacked and burned again. This second burning eliminated practically all of the woody growth and left the area flat and clear to facilitate subsequent regrowth control.

In many areas we found that the most efficient method of clearing was to operate the cutters in conjunction with the larger tractors. The cutters meandered through the saltcedars, cutting all the smaller growth and leaving the larger plants for the larger tractors. This method, where it could be used, proved to be faster and more economical. In attempting to find the most effective method of clearing, however, a horizontal cutter blade welded to the lower edge of an angle dozer blade was used as well as using the angle dozer blade without the cutter edge, but neither of these methods proved to be as efficient or as satisfactory as uprooting with the root rakes.

Over the 2-year period, the average cost of cutting the smaller growth with the rotary cutters was approximately $6.20 per acre for 1,542 acres. The cost of clearing and stacking with the root rakes averaged $13.90 per acre on 3,439 acres. These costs include all field costs, such as labor, fuel, transportation, repairs, and depreciation.

From the start it was recognized that in order to realize benefits from the saltcedar control program in the reduction of the consumptive use of water, continual control measures would be necessary. Therefore, regrowth control work was included as part of the program.

Where the initial clearing was by use of root rakes, most of the root systems were actually removed and regrowth has been slower and less dense than in areas that were cut with rotary cutters. To some extent, this offsets the higher initial clearing costs with the root rakes. Regrowth from the old root systems is quite rapid, particularly in areas with a high groundwater level. Many plants regrew to a height of 6 feet and were blooming within 3 months after initial clearing. One encouraging note, however, has been that under the conditions existing in this area there has been practically no seedling growth since the initial clearing. So far, seedlings have begun growing in only one small area.

Several types of regrowth control have been used or will be used in the future. Primarily, control has been by use of the rotary cutters since this is a fast and efficient means of obtaining temporary control. One cutting per year, at least for the first few years, should give satisfactory control. It may well be that after a few years less frequent cuttings will be required because of weakening and thinning of the plants. For about 1,700

Eighty-four-inch rotary brush cutter clearing salt cedar at Caballo Reservoir.

Clearing with large crawler tractors equipped with root rakes. Brush is piled and burned.

acres of regrowth cut during the period of this first cooperative contract, this method of control cost $2.20 per acre.

Spraying with a trailer-mounted ground sprayer has also been used for control of regrowth. The sprayer used on this work is equipped with a 600-gallon tank and four tee-jet spray nozzles attached to two 22-foot booms. These nozzles provide a uniform spray pattern over an 85-foot width. Last year 684 acres were sprayed with formulations of 2,4-D, 2,4,5-T and 2,4,5-T propionic acid silvex in various concentrations. Unfortunately, the area available for this first spraying was inundated last winter, which made evaluation of the results difficult. For future spraying, an area of 540 acres has been set aside in the upper end of the reservoir and it is planned to continue spraying for several years or until definite results can be obtained.

Cost of the spraying is more than the cost of cutting. The cost per acre varies considerably, depending on the type of chemical and the rate of application, but for the 684 acres sprayed last year the average cost was $7.05. However, if several applications of chemical will eradicate a large portion of the growth, spraying might prove to be the most economical method in the long run.

An interesting development in the area that was cleared has been the return and spread of native grasses. Prior to the clearing work, practically no grass was growing in the areas of dense saltcedar growth. In other areas of less dense saltcedar, thin stands of grass grew. Since the reservoir has been cleared, native grasses, consisting principally of bermuda and salt grass, have spread into an almost continuous cover over the entire area. In all probability this amazing spread was accelerated by a higher than normal rainfall last year. During 1958 almost 11½ inches of precipitation fell on this area, as compared with a normal amount of a little over 8 inches. On the other hand, this greater-than-normal rainfall hindered clearing operations to some extent and caused greater saltcedar regrowth than would normally be expected.

The original cooperative contract between the State of New Mexico and the Bureau of Reclamation covered the period July 1, 1957, to June 30, 1959. Another 1-year contract for continuing control of the regrowth became effective on July 1 and, providing satisfactory results are obtained, this work will probably be continued for a number of years. ###

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KEY TO THE TRINITY

A new era is on the threshold in northwestern California. Daring men and huge machines are moving mountains of earth and stone to dam the Trinity River. Layer upon layer, loads of earth are being spread, rolled, and compacted into the highest earthfill dam in the world.

This is Trinity Dam. Each day hundreds of men with scores of gigantic earthmoving equipment thunderously place and compact thousands of cubic yards of rock, gravel, and clay. The fruits of this strenuous daily effort—even the weekly progress—can scarely be discerned by the viewer's eye. Almost 3 years will be needed to complete this momentous earth placement task involving more than 33 million cubic yards. This monumental dam, slowly rising to a full height of 537 feet, is the key unit in the gigantic plan for the first transmountain diversion of water into California's fabulous Central Valley. Impounding 2,500,000 acre-feet of water, Trinity Dam provides storage at the upper end of the 30-mile water system. The lower end of the system, the delivery point of water to the Central Valley, is Keswick Reservoir on the Sacramento River. This small reservoir is located about 8 miles below Central Valley Project's famous Shasta Dam and reregu-

by RICHARD J. SHUKLE
Assistant Regional Project Development Engineer
Bureau of Reclamation, Sacramento, Calif.

Heavy equipment at rest during winter shutdown at Trinity damsite. Mountains of stone and earth will dam Trinity River.

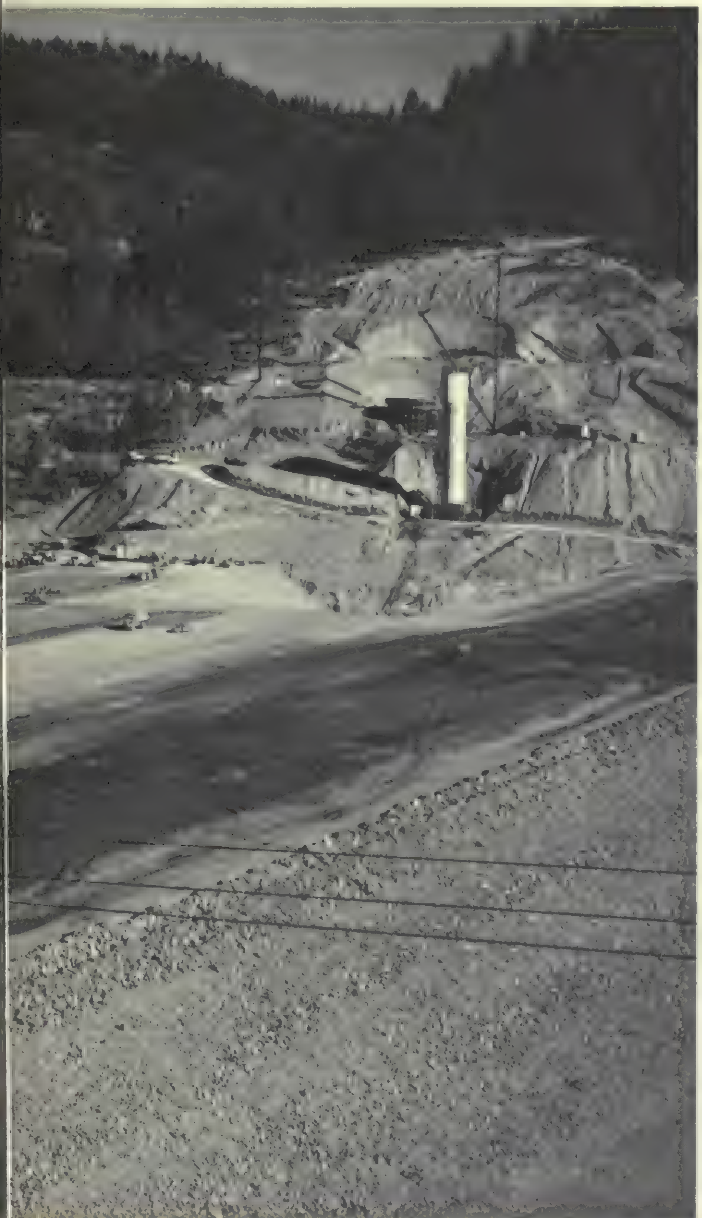
lates the flow of water released from Shasta to maintain a desired regimen in the Sacramento River. Placing Trinity River water into Keswick will bring about the integration of the water with the main artery of supply of the Central Valley Project.

When full, the water surface in Trinity Reservoir will be about 1,760 feet in elevation above the water surface in Keswick. To bridge the 30-mile distance and 1,760 feet of fall will require seven major complementary features to Trinity Dam. These include Lewiston and Whiskeytown Dams; Trinity, Clear Creek, and Spring Creek

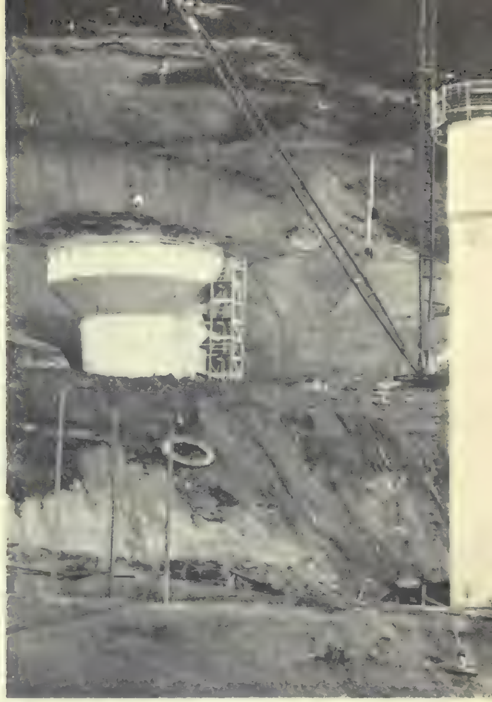
Clear Creek tunnel—line section.

Rolling the earthfill at Trinity Dam. Hundreds of men with scores o

powerplants; and Clear Creek and Spring Creek tunnels. The first of the complementary features is Trinity powerplant located at the dam. Water released from the dam will pass through this 100,000-kilowatt power facility. On leaving the plant, the water will enter a small reservoir formed by Lewiston Diversion Dam, located about 7 miles downstream from Trinity. This dam, a 70-foot-high earth, gravel, and rock fill structure will contain outlets to release water for the downstream requirements of the basin, including water for the important Trinity River fishery. Water surplus to the basin needs will be diverted from

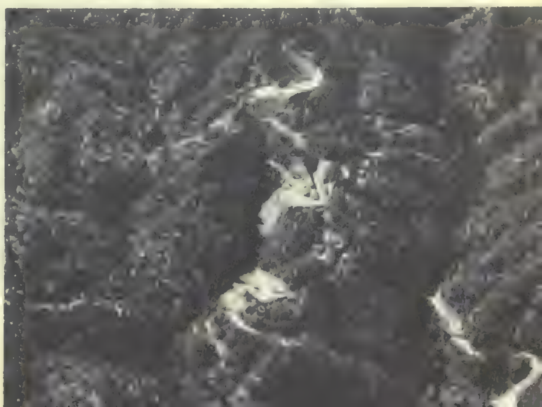


thmoving equipment place and compact rock, gravel, and clay.



Trinity spillway and gate shaft. Outlets at dam will release water for downstream use.

Aerial view of outlet portal of Clear Creek tunnel. Excavation for surge tank may be seen directly above tunnel outlet portal.



Lewiston Reservoir through Clear Creek tunnel. This 10.8-mile tunnel extends through the mountain range that separates the Trinity and the Central Valley basins. Water diverted into the 17 feet 6 inches concrete-lined tunnel, with a capacity of 3,200 cubic feet per second, will pass through Clear Creek powerplant located at its terminus and then enter Whiskeytown Reservoir. The Clear Creek powerplant, with a design head of 561 feet, will have two generating units with a total capacity of 134,000 kilowatts. Whiskeytown Reservoir on Clear Creek, a tributary of the Sacramento River, has a capacity of 250,000 acre-feet. Created by Whiskeytown Dam, an earth and rock fill structure 278 feet high, it is the last reservoir on the diversion route. From Whiskeytown Reservoir, Trinity and surplus Clear Creek water will flow through Spring Creek tunnel into the Spring Creek powerplant and then into Keswick Reservoir. Spring Creek tunnel will be driven through a short mountain ridge lying between Clear Creek and the Sacramento River. This 2.9-mile, concrete-lined tunnel will be 18 feet 6 inches in diameter and will have a carrying capacity of 3,600 cubic feet per second. Delivery of this large quantity of water to Spring Creek powerplant, with a design head of 569 feet, will operate two generating units having a combined capability of 150,000 kilowatts. This unit, the largest of the three powerplants, brings the total generating capacity of the power features to 384,300 kilowatts, including a small 300-kilowatt plant at Lewiston Dam.

The construction of Trinity Dam is now about

Trinity Dam, looking upstream. When completed it will rise to height of 537 feet.

80 percent complete. Its rapid construction has been due to the energy and ingenuity of the joint construction organization, comprising: G. F. Atkinson; M. I. Bavanda; C. L. Harney, Inc.; Ostrander Construction Co.; A. Teichert & Son, Inc.; and Tripte Construction Co. Clear Creek tunnel is the only complementary feature on which construction is in progress. Almost 9.6 miles of its total length of 10.8 miles have been excavated. Construction of this vital feature has been undertaken jointly by the Shea, Kaiser, Morrison Knudsen, and Raymond Concrete Pile Cos. Other features of the project are scheduled for construction so that the entire project will be completed by the fall of 1963. The present estimate of cost of this tremendous undertaking is $262 million.

This system will deliver each year somewhat less than 1 million acre-feet of water into the Central Valley. Realization of this transbasin diversion development has been the hope and dream of water resource developers for more than 50 years. Its construction marks the beginning of a new role for northwestern California. This five-county mountainous forest area, with limited accessibility, is a relatively unknown portion of California.

The area is as large as the Netherlands and slightly larger than the State of Rhode Island. Its 12,400 square miles represent only 8 percent of the area of California. Six rivers flow through its tortuous canyons into the Pacific Ocean. The average annual flow of these streams is about 24 million acre-feet. This is 36 percent of the average annual flow of all of the streams in California. About 143,000 people or less than 1 percent of the State's population live in the area. Most of the population is located in the flat land at points on the coast or in small inland valley areas. So mountainous is the area that in all of its 12,400 square miles there are scarcely 30 square miles of land flat enough for agricultural use or urban and industrial development. Long-term needs of the area are estimated at 1 million acre-feet annually. Thus, with less than 1 percent of the State's population, 8 percent of the land of the area has 36 percent of the water in the State. The area economy that once was gold and today is lumber will find tomorrow involved in the development of the water resource and the export of its surplus water and power to the needy and arid areas of the State.

(Continued on page 55)

GRAND VALLEY

.... *the bargain basement*

Farmer with his herd of registered Jersey cows on Grand Valley project farm near Fruita, Colo.

The common expression "you get only what you pay for" hardly applies to the beneficiaries of the Grand Valley in western Colorado. A modest investment in water resources development has been returned many times over there in the form of enhanced land values, new employment opportunities, and new sources of income. In terms of the gains realized from the basic expenditures which put water on the arid valley lands, the Grand Valley project has been a truly bargain-basement "buy."

In a typical year a charge of about $5 per acre provides the farmer with the water with which he can grow some $140 worth of crops. Without this water, all the inputs of seed, fertilizer, capital, and manpower, and all the technology and advanced science that could be lavished on the arid

land would be largely wasted. Lands outside the irrigation districts produce less than $5 worth of crops of pasturage per acre. Water has thus been the key factor in achieving more than a twenty-fold increase in the per acre productivity.

The early settlers of the Grand Valley developed irrigation systems but were limited by lack of capital to bring about complete utilization of the valley. In 1912, the Bureau of Reclamation contracted with local interests to build a diversion dam and appurtenant works to provide irrigation service for approximately 41,000 acres. The first project water was delivered for the 1915 irrigation season and has furnished a dependable supply since that date.

Towering up to 12,000 feet above sea level, the mighty peaks of the Rocky Mountains enhance this fertile valley in the upper reaches of the Colorado River, and provide it temperate haven from the raw winter blasts, the freak spring storms, and scorching summer heat that characterize the western range country. The protected valley floor at 4,600 feet above sea level has a mild climate with an average frost-free preiod of 199 days. Sunny days predominate in all seasons.

The moisture-laden clouds, borne eastward by the prevailing winds, drop their moisture as they ride the cooling updrafts over the Continental Divide. This natural phenomenon, occurring principally during the winter, blankets the slopes with snow which proves the precious runoff to feed the irrigation canals throughout the dry summer season. Climate, sufficient water, fertile

Peaches from the orchards of the Grand Valley project, being packed near Grand Junction, Colo.

Baling hay on farm near Grand Junction, Colo. Grand Valley project water brings greater return in agricultural production.

Main street, Grand Junction, Colo. This busy community is Bureau headquarters for project.

soil, and efficient management practices are conducive to the production of some 25 to 30 different crops. The area is widely noted for its fruit production which constitutes 50 percent of all fruit production in Colorado. In 1958, the value of its peach crop approached $2.5 million.

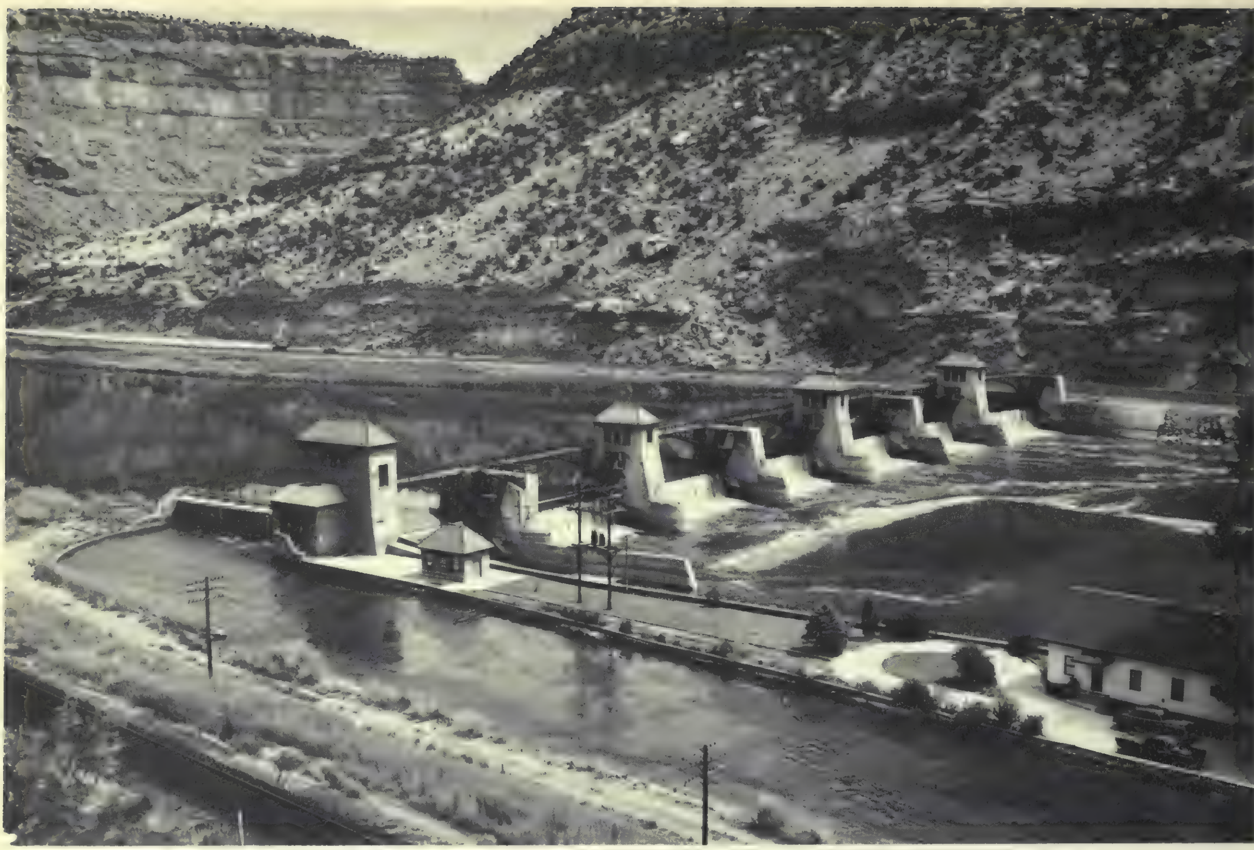
Peach harvest time in the valley is a period of hectic activity. Two cooperatives in Palisade, Colo., process the majority of the fruit, and by efficient handling methods and excellent transportation facilities, the fresh fruit reaches midwestern markets within 4 to 10 days after picking. The harvest period lasts 18 to 21 days with 50 percent of the crop processed within a 5-day period. Housewives and students join the labor force to help with the harvest. Agricultural employment at this time reaches 13,000 to 14,000 persons. Canneries in the project towns of Grand Junction and Delta process the peaches which are not sold as fresh fruit. Grand Valley-canned peach production averages about 300 carloads annually.

Despite the justly deserved publicity associated with the peach harvest, other crops really provide the broad foundation for the economy of the Grand Valley. Among these are sugar beets, corn, alfalfa, dry beans, and tomatoes.

The economy of Mesa County, site of the Grand Valley Project, is based principally on livestock. Forty-eight percent of the income for the county is derived from livestock or livestock products. The practice of fattening cattle and sheep on locally produced feed crops is becoming widespread. At the present time, there are about 25,000 animal units fed annually on the irrigated farms. Further expansion of livestock feeding is expected to accompany the improvements indicated by hybrid corn experiments and the progress being made in the science of livestock nutrition. The principal markets for Grand Valley livestock are Kansas City and Los Angeles.

An irrigation benefit little understood is that of providing operating bases during the decade of intensive uranium prospecting activity in the West. Remote and uninhabited, the areas adjacent to the Grand Valley were found to be among the richest sources of uranium-bearing ores. This is a country largely without roads or communications outside the irrigated stream valleys. The centers of population, built as a result of irrigation farming, played a role of inestimable value in facilitating the important search for strategic minerals. There is no way of calculating how great was the saving in time, money, and manpower from the fact that these points of access were present when most needed. In return, the proving of the Colorado Plateau as a source of rare minerals has resulted in important business expansion and new local markets for products of the irrigated farms.

Paonia lass poses with basket of luscious Elberta peaches for which Grand Valley is famous.



General view of Grand Division Dam on Colorado River, constructed in 1915 by Bureau of Reclamation to divert water for Grand Valley irrigation.

The American Gilsonite Co. completed a new $16 million plant near Fruita in 1957. Gilsonite, a solid hydrocarbon, is converted to liquid petroleum and high-purity coke. The daily production from 700 tons of gilsonite yields 250 tons of coke, 1,300 barrels of high-octane gasoline, and 300 barrels of fuel oil.

Upstream from the Grand Valley are located extensive deposits of oil shale. For a number of years the U.S. Bureau of Mines operated a pilot plant near Rifle, Colo., conducting experimental work in the production of oil from shale. The following paragraphs are excerpts from the *Economic Potential of Western Colorado* by Bureau of Business Research, University of Colorado, 1953:

"It appears that an oil shale industry for both its products and byproducts is feasible at this time. With continued increasing demand, further depletion of petroleum reserves, and with continued research to improve costs and products, the birth of this industry might not be too far in the future.

"Expansion in mining, petroleum, and minerals exploration, industrialization, and a growing agriculture indicates a bright future for the Grand Valley. Each is dependent to some degree on conservation and efficient use of water supplies. As the nonfarm segment of the population grows, the local market for the products of irrigated farms will be enhanced." ###

Overlooking Government Canal which supplies water to lush farmlands of Orchard Mesa Irrigation District.

water report

by HOMER J. STOCKWELL, Snow Survey Supervisor, Soil Conservation Service, Portland, Oreg., and J. ALDEN WILSON, Assistant Snow Survey Supervisor, Soil Conservation Service, Boise, Idaho.

Streamflow will be below normal for most snow-fed western streams in 1960. In many areas of Utah, Nevada, Idaho, Oregon, and California, forecasts of streamflow range near one-half of average. Only in Colorado, New Mexico, and Arizona is the snowmelt runoff expected to exceed normal.

Storage in larger irrigation reservoirs built up during the high runoff years of 1957 and 1958 was depleted substantially in 1959. In the areas where below normal runoff is forecast for 1960, this depletion will continue. On smaller streams without storage where low runoff is expected, serious deficiencies in water supply, particularly in late season, are almost certain. Along the major rivers, water supplies will be adequate or the shortages will tend to be alleviated because of carryover storage, or because water supply normally far exceeds the demand. Again this year, the need for storage on small streams is apparent.

This article was made possible through the efforts of *R. A. Work*, Head, Water Supply Forecasting Section, Soil Conservation Service, USDA.

Forecasts of 1960 irrigation water supply and general water supply conditions are based on April 1 measurements by the U.S. Department of Agriculture, Soil Conservation Service and many cooperating organizations [1] on over 1,400 snow courses and 100 soil moisture stations. In addition to this information, streamflow and precipitation data are used in preparing streamflow forecasts. The amount of water stored in over 250 reservoirs is considered in appraising water supply outlook. Plans of management of water-using organizations and the relative demand for water in an area is recognized as an integral part of the general water supply situation.

With the widespread shortage of water expected this year, and the variation in outlook over rela-

[1] The Soil Conservation Service coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal Bureaus, various departments of the several States, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that State, contributed the California figures appearing in this article. The Water Rights Branch, British Columbia Department of Lands and Forests has charge of the snow surveys in that province and likewise contributed the information here for British Columbia.

tively small areas, irrigation water users and others are urged to become familiar with local water supply conditions and plan their operations accordingly. Crop plans should be in line with prospective water supplies to avoid financial loss due to lack of water. In this brief report, water supply conditions can be described only in general terms.

In summary, water supplies in California will be seriously deficient during the coming season. Snowmelt season runoff for the majority of the streams will be in the range of 50 to 60 percent of normal. Streams tributary to the San Joaquin will be as low as 25 to 40 percent of normal. Forecasts are slightly higher than the streamflow which occurred in 1959. The consecutive dry years make the 1960 shortage even more serious and will result in further lowering of the groundwater table in many areas.

Late season shortages will be general for irrigated areas in Oregon. Most seasonal runoff forecasts are in the range of 60 to 85 percent of normal. Carryover storage is near average for the State, but is variable among the individual watersheds. Flow in streams to the east of the Sierras in Nevada will be about one-half of normal. The Humboldt River is forecast at less than one-quarter of normal. Reservoir storage is much below average. In Nevada and many areas of Oregon, water supplies will have to be carefully utilized.

Streamflow in Washington is expected to range from 50 to 80 percent of normal on Columbia River tributaries. Storage in irrigation reservoirs is above normal. Shortages are in prospect only where limited or no storage is available.

Seasonal streamflow on the main stem of the Snake River in Idaho will be near 60 percent of normal. No shortages are expected along the main stem because of storage. Severe shortages are in order for the tributary streams flowing from the north and south into the Snake in central Idaho, except for the Boise and Payette.

Water supply shortages are expected for much of Utah. Forecasts of streamflow range from 50 to 80 percent of normal except for a few areas of the Colorado River Basin. Reservoir storage is about 75 percent of normal.

In Arizona the surface water supply outlook is better than for any recent year. Winter runoff has been high on the Salt and Gila Rivers. Above normal runoff is expected through April and May. Reservoir storage has improved and is now well above the past 15-year average. However, demands remain high. Along the Rio Grande in New Mexico, summer runoff is expected to be slightly above the long-term normal and considerably above the average flow of recent years. Storage for the Carlsbad and Tucumcari projects is much above average. Water supply outlook on the eastern plains is good.

The snowpack in Colorado is normal or better. Some shortage may be expected in the Arkansas Valley, due to lack of storage, but elsewhere in the State water supplies should be average to good. Flow of the Rio Grande, San Juan, and Dolores Rivers will be in excess of normal. Local and supplemental water from transmountain diversions will provide an adequate supply for South Platte tributaries.

In Wyoming, the water supply outlook is not so favorable. Inflow to the major reservoirs in the North Platte is forecast at 63 percent of normal. The good carryover storage of a year ago has been considerably depleted, but if rainfall during the irrigation season is favorable demands may be met along the main stream in both Wyoming and western Nebraska. Other streams in Wyoming are forecast at 60 to 70 percent of normal. Only late season shortages where no storage is available are in prospect.

The flow of upper Missouri River tributaries in Montana is forecast at near 80 percent of normal with the flow of the Yellowstone expected to be slightly less. Shortages are expected only along small streams. On Columbia River tributaries, forecasts range near three-quarters of normal.

Forecasts of major streams of the West as compared to normal for the April–September period are as follows. Forecasts in California are for April–July.

Columbia River at The Dalles, Oreg., 95,600,000 acre-feet or 90 percent

Missouri River at Fort Benton, Mont., 2,955,000 acre-feet or 82 percent

Colorado River at Grand Canyon, Ariz., 8,860,000 acre-feet or 97 percent

Sacramento River inflow to Shasta Reservoir, California, 1,580,000 acre-feet or 80 percent.

San Joaquin River below Friant Reservoir, California, 670,000 acre-feet or 53 percent

Rio Grande at Otowi Bridge, New Mexico, 1,008,000 acre-feet or 158 percent

The following paragraphs describe briefly the water supply outlook by states.

This article is prepared for RECLAMATION ERA from information supplied by the Snow Survey and Water Supply Forecast Section, Soil Conservation Service, United States Department of Agriculture.

ARIZONA: Early winter precipitation established a heavy snowpack at higher elevations. Spring runoff has been well above normal. The water supply outlook for Arizona is very good, as compared to recent years. Water stored in reservoirs is 184 percent of the 1943–57 average. There should be some carryover storage for next year in the Salt River Valley and a few other areas.

Forecasts of flow for April and May on the Salt and Gila main stems are about 125 percent of normal. An exception is the Verde above Horseshoe Reservoir which is only 62 percent of normal.

CALIFORNIA: The California Department of Water Resources reports that this is the second consecutive dry year for California. Runoff of streams is below normal in all areas. Seasonal precipitation to date and the water stored as snow at the higher elevations are well below average in all areas. Resultant April–July streamflow, as indicated by these and other factors, will be in the

range of 50 to 60 percent of average on most snow-fed streams, with extremes of 25 percent of average on the Tule River and 80 percent on the Trinity River.

In California, April 1 is generally considered to be the end of the snow accumulation season and the beginning of the melt period. After April 1 there is little hope of improving the water supply situation. This will be a dry year, and although not as bad as last year, it does follow a dry year. The shortage of water will result in a further lowering of groundwater levels in many areas, in addition to the more immediate and apparent effects.

The statewide precipitation average for the season to date is about 80 percent of normal. This is approximately 15 percent higher than on this date last year, but about the same percentage as at the end of last month. Storms during March brought above normal precipitation to the northern portion of the State, and improved water supply conditions for that area. In the southern portion of the State, however, where the need for water is much more critical, March precipitation was well below average.

As of April 1, snow stored water was much below normal in all snow accumulation areas of the State, ranging from about 50 percent of average in the Kings-Kern area to 75 percent in the upper Sacramento River basin. Although storms in early and late March deposited significant deposits of snow, the high temperatures during mid-March melted large segments of the lower elevation snowpack. As a result forecasts of April–July runoff on most streams have been lowered from those of 1 month ago.

COLORADO: Water supplies should be adequate along most of the principal snowmelt streams in Colorado for 1960. Mountain snowpack as of April 1 is above normal at higher elevations. Mountain and valley soils are in excellent condition which will tend to increase snowmelt runoff and cut down on early season irrigation demands.

Reservoir storage is slightly above normal on the South Platte and below normal on the Arkansas and Rio Grande. Because of lack of storage, the outlook is only fair on the Arkansas below Pueblo.

In northwestern Colorado, stream flow will be slightly more than normal and adequate to meet all but late season demands in small tributaries. The San Juan, Dolores, Animas, and Rio Grande drainages will have excellent water supplies for the 1960 season.

The flow of the South Platte tributaries near the mountains is expected to be near normal. With Colorado-Big Thompson supplemental water, the outlook is good.

IDAHO: Snowfall throughout Idaho for March was variable, but seasonal totals continued below normal. The main rivers used for irrigation, such as the Snake, Payette, and Boise have excellent carryover storage and a normal water supply is in prospect even though the snowpack on the watersheds is far below normal.

The small rivers running north and south into the Snake, such as Salmon Falls Creek, Goose Creek, Trapper Creek and Big Wood, Little Wood, Big Lost and Little Lost Rivers, with limited storage facilities, face a critical water shortage because of the low carryover storage and low streamflow in prospect for 1960. Streamflow in northern Idaho is expected to be about 80 percent of normal which should provide adequate irrigation water supplies.

Water users are planning for the most efficient use of water in the areas of extreme shortage.

KANSAS: Prospects for irrigation water along the Arkansas River are only fair. The runoff of the river will be similar to 1959 but the storage in John Martin Reservoir is only about one-tenth of that stored last year. Soil moisture is good.

MONTANA: The 1960 water supply outlook for Montana is only fair. Exceptionally warm weather during the last 2 weeks of March removed most of the low elevation snow. This warm period has ripened the high elevation snowpack which indicates an early spring runoff.

High base flow in the streams during the winter and an above normal fall precipitation raised the forecasts above that which normally could be expected from the snowpack. Soil moisture under the snow throughout the State is exceptionally high for April 1..

The Jefferson, Madison, and Gallatin Rivers will combine to make a close to 80 percent normal snowmelt for the Upper Missouri.

The Columbia River basin snowpack in Montana is only 75 percent of normal. The South Fork of the Flathead River below Hungry Horse Dam is forecast at 70 percent of normal. The Flathead River at Columbia Falls is forecast to flow 1,819,000 acre-feet during the April–September period, or 79 percent of normal. This is 40 percent less flow than last year.

NEBRASKA: Inflow to the major reservoirs of Wyoming will be short on the North Platte. With carryover storage, water supplies along the North Platte will meet demands unless summer rainfall is extremely deficient. Soils in irrigated areas are now near field capacity as a result of above normal winter and early spring precipitation. Storage on Kansas River tributary reservoirs has filled the irrigation pools and extends into flood control storage.

NEVADA: Nevada water supply outlook for the coming summer is poor to fair. The outlook declined during the past month due to below normal snowfall, except for near normal snowfall at high elevations in northeastern Nevada. This lack of March snowfall coupled with unseasonably high temperatures and warm winds, and dry mountain soil conditions has resulted in the downward revision of streamflow forecast estimates from March 1.

Reservoir storage is low, with only 58 percent of normal April 1 storage. None of the principal reservoirs in the State is expected to fill to capacity. Most irrigation district managers and water officials expect sufficient water to avoid serious crop damage. However, careful management of limited water supplies by Nevada water users through efficient irrigation practices plus some concentration to lesser water using crops will be necessary. If precipitation continues to be deficient on the Humboldt watershed, water supplies could be extremely deficient.

NEW MEXICO: The water supply outlook for New Mexico is much improved over last year and will probably be similar to 1957. Snowpack in New Mexico is about 125 percent of normal. Soil moisture conditions are better than they have been since 1957. High temperatures near the end of March melted the low snow. Streamflow is increasing.

Storage in Elephant Butte and Caballo Reservoirs is below normal, but not critical. Storage on smaller irrigation systems is generally below normal. Inflow to all reservoirs should be above that of recent years.

Conchas Reservoir on the Canadian River has above normal storage and with above normal snowmelt runoff, this area should have adequate water supplies. Storage in Alamogordo on the Pecos River is almost twice normal but less than last year.

Most irrigated areas which depend on snowmelt streams for water should have a good irrigation season as compared to the past few years.

OKLAHOMA: The winter precipitation has been generally above normal. Altus Reservoir is considerably above average and almost full. This should insure a good water supply this summer.

OREGON: Outlook for irrigation water supplies in Oregon improved slightly during March but still is below average in all areas and poor in many. Forecasts range from 60 to 85 percent of normal with a low of 47 percent on the Silvies River. Reservoir storage is near average. Late season shortages of irrigation water will be general in practically all areas of the State, with the exception of the Rogue and Klamath where barely satisfactory water supplies are anticipated. The Harney Basin has the poorest outlook in the State. Other areas where runoff shortages will be relatively severe include several parts

of Wallowa, Baker, and Union Counties, John Day and Crooked Rivers and their tributaries.

SOUTH DAKOTA: Winter precipitation has been above normal in the Black Hills area. High temperatures during late March reduced the mountain snowpack to near normal. Reservoir storage is about 80 percent of normal. Substantial water shortages in surrounding irrigation districts can be expected this year unless summer rainfall is normal or better.

TEXAS: Water supply outlook for west Texas along the Pecos and Rio Grande is fair. Storage is slightly below normal in Elephant Butte. Storage in Red Bluff Reservoir on the Pecos is also below normal. Inflow into these reservoirs should be about 150 percent of the 1943–57 normal. It is noted that the streamflow during the 1943–57 period is much below the long-term average for the Rio Grande.

UTAH: Snowmelt season streamflow will be below normal for most of the State. Water supply shortages are expected on the Upper Sevier and Virgin Rivers and adjacent streams, the Spanish Fork and Strawberry Rivers, East Canyon Creek near Morgan, Chalk Creek near Coalville, and the main stem of the Bear River in the Woodruff-Randolph area. Forecasts for these streams range from 50 to 65 percent of normal. The streams in the Uintah Basin are forecast at 70 to 80 percent of normal. Water supplies for the remainder of the State will be near 80 percent of normal. The North Fork of the Ogden River, Salina Creek, and streams in the Montecello-Blanding area of southeastern Utah are forecast at 110 to 120 percent of normal.

Reservoir storage is only 75 percent of normal not including Utah and Bear Lakes.

WASHINGTON: The water supply outlook for the State of Washington varies from fair to poor. Forecasts of runoff on the Columbia, Chelan, Methow, Cowlitz, and Lewis Rivers and Ahtanum Creek are for flows 80 percent of normal or better. The remainder of the streams in the State can expect less than 80 percent normal runoff during the April–September period.

Heavy precipitation this past fall primed the soil at higher elevations which will materially help the spring runoff picture and should maintain better late summer flows than could be expected from the below normal snowpack. Base flows as of November 1959 were exceptionally high. This factor also tends to increase forecasts over that expected from the snowpack.

Reservoirs used for irrigation in the State have more water in storage than normal for this time of year, except Franklin D. Roosevelt Lake. The irrigation picture is good for those areas below reservoir storage. Runoff during March was generally above normal for all streams in the State, except those near the Oregon border.

WYOMING: Snow water content measured in mountain areas of Wyoming on April 1 was seriously deficient, generally in the range of 50 to 75 percent of normal. Soil moisture under the snow is above normal which will add slightly to the expected runoff. Seasonal runoff will be short and reservoir storage will continue to be reduced. Anticipated flows range from about 63 percent of normal on the North Platte in southeastern Wyoming to 70 percent of normal on the Green and Wind Rivers. The Snake at Moran is forecast at about 60 percent of normal.

Reservoir storage on the North Platte is 80 percent of normal in the large reservoirs. In combination with inflow, water supplies along the North Platte should be reasonably adequate this year. Tributaries will experience shortages. Soil moisture conditions in irrigated areas are relatively good.

###

WATER STORED IN WESTERN RESERVOIRS

(Operated by Bureau of Reclamation or Water Users except as noted)

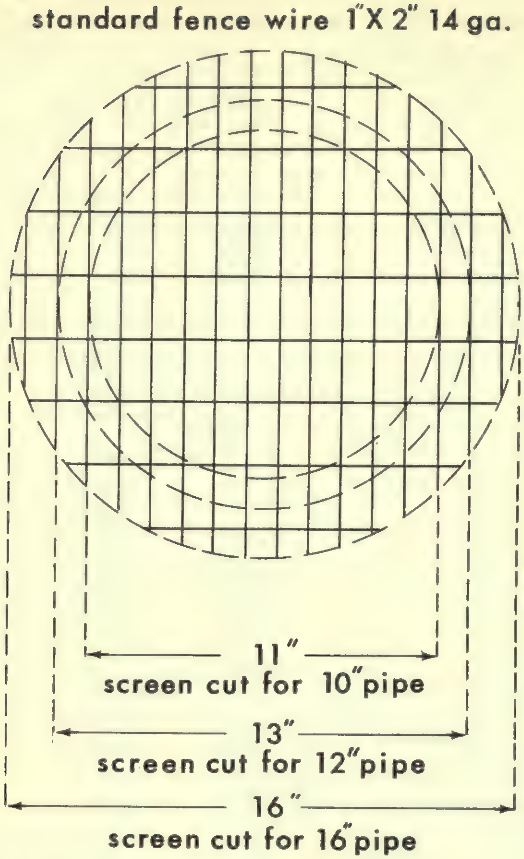
Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Mar. 31, 1959	Mar. 31, 1960
Region 1	Baker	Thief Valley	17,400	17,400	17,400
	Bitter Root	Lake Como	34,800	21,800	20,100
	Boise	Anderson Ranch	423,200	290,700	324,400
		Arrowrock	286,600	275,100	274,500
		Cascade	654,100	407,100	443,200
		Deadwood	161,900	70,500	84,500
		Lake Lowell	169,000	154,300	142,200
		Lucky Peak	278,200	180,800	229,800
	Burnt River	Unity	25,200	19,200	17,800
	Columbia Basin	F. D. Roosevelt Lake	5,072,000	2,672,000	2,724,000
		Banks Lake	761,800	764,500	536,600
		Potholes	470,000	277,800	268,800
	Deschutes	Crane Prairie	55,300	54,000	2,800
		Wickiup	187,300	200,000	183,000
	Hungry Horse	Hungry Horse	2,982,000	1,839,600	2,395,000
	Minidoka	American Falls	1,700,000	1,603,100	1,616,200
		Grassy Lake	15,200	11,900	11,900
		Island Park	127,200	126,900	134,200
		Jackson Lake	847,000	484,900	478,400
		Lake Walcott	95,200	93,400	87,200
	Ochoco	Ochoco	47,500	31,800	12,700
	Okanogan	Conconully	13,000	9,700	9,100
		Salmon Lake	10,500	8,900	10,100
	Owyhee	Owyhee	715,000	523,800	464,200
	Palisades	Palisades	1,202,000	724,000	876,000
	Umatilla	Cold Springs	50,000	50,000	50,000
		McKay	73,800	68,500	43,100
	Vale	Agency Valley	60,000	34,500	36,400
		Warm Springs	191,000	133,800	92,000
	Yakima	Bumping Lake	33,700	8,100	14,300
		Clear Creek	5,300	5,300	5,300
		Cle Elum	436,900	341,800	325,800
		Kachess	239,000	190,700	203,700
		Keechelus	157,800	118,700	108,900
		Tieton	198,000	140,400	176,100
Region 2	Cachuma	Cachuma	201,800	200,200	178,100
	Central Valley	Folsom [1]	920,300	472,200	612,200
		Jenkinson Lake	40,600	40,800	40,800
		Keswick	20,000	17,200	17,800
		Lake Natoma	8,800	8,500	8,500
		Millerton Lake	427,800	243,100	128,100
		Shasta Lake	3,998,000	3,280,000	3,393,500
		Lake Thomas A. Edison	125,100	61,700	37,600
	Klamath	Clear Lake	513,300	287,400	182,400
		Gerber	94,300	55,100	25,000
		Upper Klamath Lake	524,800	406,300	393,200
	Orland	East Park	50,600	50,900	50,600
		Stony Gorge	50,000	51,200	51,800

[1] Corps of Engineers Reservoir.

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Mar. 31, 1959	Mar. 31, 1960
Region 3	Boulder Canyon	Lake Mead	27, 207, 000	20, 735, 000	19, 171, 000
	Parker-Davis	Havasu Lake	216, 500	565, 800	546, 300
		Lake Mohave	1, 809, 800	1, 702, 800	1, 568, 200
	Salt River	Apache Lake	245, 100	242, 000	235, 000
		Bartlett	179, 500	71, 000	145, 000
		Canyon Lake	57, 900	53, 000	58, 000
		Horseshoe	142, 800	43, 000	76, 000
		Roosevelt	1, 381, 600	405, 000	1, 022, 000
		Sahuaro Lake	69, 800	48, 000	66, 000
Region 4	Eden	Big Sandy	38, 300	5, 100	4, 500
	Fruitgrowers Dam	Fruitgrowers	4, 500	4, 000	2, 400
	Humboldt	Rye Patch	190, 000	123, 200	27, 800
	Hyrum	Hyrum	15, 300	12, 900	12, 900
	Mancos	Jackson Gulch	9, 800	4, 000	1, 600
	Moon Lake	Midview	5, 800	6, 200	5, 700
		Moon Lake	35, 800	10, 500	12, 400
	Newlands	Lahontan	290, 900	254, 000	(2)
		Lake Tahoe	732, 000	554. 400	3, 100
	Newton	Newton	5, 400	2, 300	3, 100
	Ogden River	Pineview	110, 200	22, 000	30, 400
	Pine River	Vallecito	126, 300	47, 000	44, 300
	Provo River	Deer Creek	149, 700	86, 100	76, 900
	Scofield	Scofield	65, 800	35, 700	8, 000
	Strawberry Valley	Strawberry Valley	270, 000	157, 700	109, 600
	Truckee Storage	Boca	40, 900	2, 100	22, 200
	Uncompahgre	Taylor Park	106, 200	56, 700	49, 900
	Weber River	Echo	73. 900	38, 600	41, 100
Region 5	W. C. Austin	Altus	162, 000	86, 500	139, 800
	Balmorhea	Lower Parks	6, 500	5, 700	5, 000
	Carlsbad	Alamogordo	122, 100	124, 400	97, 700
		Avalon	6, 000	1, 900	1, 100
		McMillan	32, 300	29, 900	20, 700
	Colorado River	Marshall Ford	1, 837, 100	746, 500	761, 900
	Middle Rio Grande	El Vado	194, 500	2, 800	14, 300
	Rio Grande	Caballo	340, 900	185, 200	91, 200
		Elephant Butte	2, 185, 400	889, 100	554, 600
	San Luis Valley	Platoro	60, 000	34, 000	4, 000
	Tucumcari	Conchas [1]	467, 300	254, 800	228, 200
	Vermejo	Reservoir No. 2	2, 900	2, 500	1, 400
		Reservoir No. 13	5, 000	4, 200	4, 800
		Stubblefield	16, 100	8, 900	6. 200
Region 6	Missouri River	Angostura	92, 000	50. 600	28, 800
		Boysen	710, 000	100, 100	139, 600
		Canyon Ferry	1, 615, 000	1, 346, 200	1, 509, 700
		Dickinson	13, 500	5, 800	5, 900
		Fort Randall [1]	4, 900, 000	2, 979, 000	3, 220, 000
		Garrison [1]	18, 100, 000	3, 965, 900	5, 020, 900
		Lake Taschida	218, 700	78, 300	75, 100
		Jamestown	39, 200	11, 400	10, 400
		Keyhole	190, 300	4, 700	14, 800
		Lewis and Clark Lake [1]	385, 000	306, 400	402, 700
		Pactola	55, 000	19, 400	25, 400
		Shadehill	300, 000	86, 000	82, 400
		Tiber	762, 000	145, 500	116, 900
	Belle Fourche	Belle Fourche	185, 200	58, 200	60, 900
	Fort Peck	Fort Peck [1]	14, 839, 000	5, 136, 900	6, 860, 800
	Milk River	Fresno	127, 200	86, 800	133, 400
		Nelson	66, 800	42, 500	50, 200
		Sherburne Lake	66, 100	36, 900	21, 300
	Rapid Valley	Deerfield	15, 100	9, 300	1, 700
	Riverton	Bull Lake	152, 000	45, 500	36, 600
		Pilot Butte	31, 600	12, 100	26, 000
	Shoshone	Buffalo Bill	380, 300	13, 600	128, 000
	Sun River	Gibson	105, 000	61, 900	79. 500
		Pishkun	30, 100	19, 400	21, 600
		Willow Creek	32, 400	28, 700	18, 500
Region 7	Colo.-Big Thompson	Carter Lake	108, 900	81, 500	80, 000
		Granby	465, 600	246, 000	216, 400
		Green Mountain	146, 900	49, 100	57, 600
		Horsetooth	141, 800	95, 400	107, 400
		Shadow Mountain	1, 800	600	600
		Willow Creek	9, 100	2, 000	3, 100
	Missouri River Basin	Bonny	167, 200	40, 900	45, 000
		Cedar Bluff	363, 200	171, 900	206, 600
		Enders	66, 000	32, 100	43, 600
		Glendo	786, 300	407, 000	380. 400
		Harlan County [1]	752, 800	247, 200	380, 300
		Harry Strunk Lake	85, 600	35, 800	43, 100
		Kirwin	304, 800	80, 900	95, 400
		Lovewell	87, 000	36, 200	36, 100
		Swanson Lake	249, 800	118, 000	136, 800
		Webster	257, 400	69, 500	87, 200
	Kendrick	Alcova	24, 500	27, 100	28, 000
		Seminoe	957, 000	597, 200	252, 400
	Mirage Flats	Box Butte	30, 400	24, 400	27, 100
	North Platte	Guernsey	39, 800	8, 300	32, 500
		Lake Alice	11, 200	4, 400	4, 800
		Lake Minatare	59, 200	37, 600	30, 300
		Pathfinder	1, 010, 900	186, 400	277, 400
Alaska Dist	Eklutna	Eklutna Lake	160, 000	60, 400	71, 400

[1] Corps of Engineers Reservoir.
[2] Not reported.

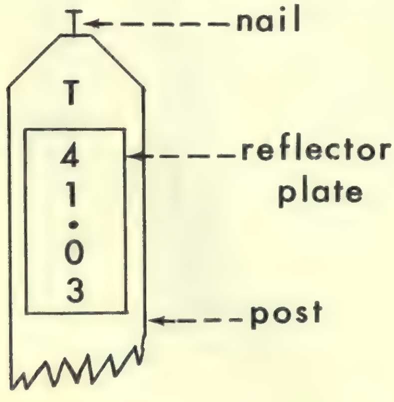


DO-IT-YOURSELF

(Continued from page 36)

showing the mileage from the Tracy pumping plant. Recently, luminous reflector plates, also bearing the mileage number, were installed on the upstream faces of the posts to aid in locating and identifying the headgates by ditchriders working at night.

The mileage posts provide ideal perches for small birds and are soon defiled by them, which not only makes the posts unsightly but defeats the purpose of the posts by rendering the stenciled numbers illegible. Because of this, the posts must be repainted often. The bird droppings were also damaging the luminous paint on the reflector plates, and if not protected the plates would have soon needed to be replaced.



The posts are shaped at the top by a bevel cut on all four sides, leaving only a small flat place on top of the posts where a bird could perch, as shown in the sketch below. It was the suggestion of H. L. Craig, irrigation operator, Tracy Operations Field Branch, Tracy, Calif., that a 16- or 20-penny box nail be driven into the top of each mileage post, leaving 2 or 3 inches of the nail exposed.

The protruding nail makes it impossible for a bird to come to rest on the post. The nail is also inconspicuous and in no way interferes with men or equipment working on the canal. The cost is negligible.

The suggestion has been tried and has eliminated the bird problem. It is to be adopted for all milepost markers along the canal.

POWER CROSSCUT SAW GUARD

Even when not in operation, power crosscut saws make very dangerous weapons. Not only that, it isn't too difficult to damage the chain teeth or the steel extension plate on which the chain rides. Jack C. Raftery, Assistant Chief Ranger, Crater Lake National Park, uses a simple cover to prevent personal injury from these saws and at the same time provides a degree of protection for the saw itself.

The protective cover, described in Grist, a publication issued by the National Conference on State Parks in cooperation with the National Park Service, U.S. Department of the Interior, consists of a piece of discarded 1½-inch, cotton-jacketed, rubber-lined fire hose long enough to go around the exposed chain. Mr. Raftery slits the hose its entire length along one of the creases and then, in dead center of its length, he cuts a V-notch. The notch will permit a custom fit at the outer end of the blade. The guard is held in a wraparound position with two rubber bands cut from a discarded inner tube.

For the two-man type of power saw, a similar cover can be provided, except two lengths of hose long enough to cover the exposed teeth, both top and bottom, are used. There is no need to go around the outer handle. This cover also can be held in place by inner tube rubber bands. ###

TRINITY

(Continued from page 44)

Trinity is the first example. Trinity Dam will provide river control that will reduce flood hazard and also maintain and improve summer streamflow conditions to the aid of the important fishery. Each year sees the migration of salmon and steelhead up the Trinity. To compensate for loss of spawning area located above Trinity Dam, a large fish hatchery will be constructed at Lewiston Dam. The combined operation of the hatchery and year-round control of flows in the Trinity River are expected to provide water conditions to enhance the fishery potentials of the stream. With 17,000 acres of new lake area at Trinity, and Lewiston having about 135 miles of accessible wooded shoreline, tremendous new recreation opportunities will occur. California's growing population will rapidly take full advantage of this recreation potential. Thus, the local people will receive the many benefits of river control, road improvements, and the environment change brought about with the construction of a large lake in the area. The export of less than 1 million acre-feet of Trinity River water out of an average annual flow of 3,200,000 acre-feet in no way will be detrimental to the area.

The export water supply and the hydroelectric power are of tremendous importance to the populated and arid areas of the Central Valley. Integrating the water from Trinity with the Central Valley water will make available a new supply of 1,400,000 acre-feet for water users in the Sacramento and San Joaquin Valleys. Combining the Trinity system powerplants with existing plants of the Central Valley project results in a total rated capacity of about 1 million kilowatts. Their integrated operation will each year produce about 3,800 million kilowatt-hours of energy for use in northern California.

Trinity water will contribute to the supplemental water supply of more than 700,000 acres of irrigated land. Some of these lands are located in Shasta County within 50 miles of Trinity. A large portion of the land is located in the Sacramento Valley and the delta of the Sacramento River. About half is located in the San Joaquin Valley. Thus, water from Trinity, directly or indirectly, benefits lands extending almost 500 miles south of Trinity Reservoir.

The spectacular features of the project are always the dams, tunnels, and the powerplants, but the 700,000 acres of irrigated land enjoying the waters from the project far exceeds one's imagination. Today, 2,000 men toil to build a great project. To complement this effort will require the work of many individuals in communities extending hundreds of miles to the south. Their job will be to improve the land and build the farm irrigation enterprises and the community services that will support it. For each dollar that is spent in building the project, many more dollars will be spent by the water users and the communities receiving water.

In true respects, the spectacular accomplishment is not the engineering works that divert a great river into a water deficient basin but, instead, it is the work of the individual farmers, their families, and their communities which make an irrigation economy a success. On a sustaining basis, their visions are the force that develops the plans and now is pressing the construction of this great project. ###

Nat Tolman—Region 7 Irrigation Supervisor

Nathaniel E. (Nat) Tolman of McCook, Nebr., has been appointed supervisor of irrigation for Region 7 of the Bureau of Reclamation in Denver, Regional Director John N. Spencer announced recently.

Tolman, who was chief of irrigation operations in the Bureau's Kansas River projects office at McCook, was promoted to the position occupied by Spencer until he was named director last September.

As supervisor of irrigation, Tolman will direct the operation of 27 Bureau reservoirs in Colorado, Wyoming, Nebraska, and Kansas. These have an aggregate capacity of nearly 6 million acre-feet, to provide irrigation water for 1¼ million acres.

He is a native of Nebraska and a 1925 graduate of its State university. After operating his family's farm at Silver Creek, he served as Box Butte, Nebr., county agent for 8 years. He was employed by the Department of Agriculture for 6 years before entering the Bureau at McCook in 1946. #

It takes only fifty years to wash down seven inches of topsoil that has taken thousands of years to build up.—*Twentieth Century Fund.*

ACTING SECRETARY OF THE INTERIOR ELMER F. BENNETT SIGNING FIRST REPAYMENT CONTRACT WITH A STATE

The State of California has appropriated $13,740,000 to underwrite a major share of costs for which Central Valley water-user organizations ultimately will contract as their allocated share of conservation costs of the proposed New Hogan and Black Butte Dams.

Seated with Secretary Bennett is Senator Thomas H. Kuchel. Standing, l. to r., are Representatives John E. Moss and Harold T. Johnson, Reclamation Commissioner Floyd E. Dominy, and Representative John J. McFall.

GLEN CANYON BRIDGE NOMINATED AS AN OUTSTANDING ACHIEVEMENT

The Glen Canyon Bridge, a feature of the Glen Canyon Unit, Colorado River Storage Project, is one of 12 civil engineering undertakings nominated by Districts of the American Society of Civil Engineers for the "Outstanding Civil Engineering Achievement of 1959." To be judged by a jury of eight engineering magazine editors, the winner—the most outstanding achievement—will be announced by the ASCE Board of Direction at the society's convention, to be held in New Orleans, La., next month. The steel arch bridge, spanning the 1,200-foot-wide gorge of the Colorado River at the Glen Canyon Dam site, was nominated by the society's District 11, which includes Utah, Arizona, Nevada, and California.

ROLIN TO HEAD SAN ANGELO JOB

G. Raymond Rolin, a veteran of more than 20 years' experience in water resources planning and construction, has been named construction engineer in charge of the San Angelo project in Texas, the Department of the Interior announced today.

The appointment was made by Commissioner of Reclamation Floyd E. Dominy.

Mr. Rolin, who holds B.S. and M.S. degrees in engineering from the Massachusetts Institute of Technology, has been construction engineer on the Ventura River project in California. He has been with the Bureau of Reclamation since 1933 with the exception of the war years and 18 months as a civilian with military construction agencies.

The San Angelo project is a multipurpose facility near the city of San Angelo in west Texas. It will provide a full water supply for irrigation of 10,000 acres of land and for municipal and industrial water for San Angelo, as well as flood control, fish and wildlife, and recreational benefits. Repayment contracts have been executed with the San Angelo Water Supply Corporation and Tom Green County Water Control and Improvement District No. 1. #

RALPH PARSHALL DIES IN COLORADO

Ralph Parshall, Fort Collins, Colo., internationally known authority on irrigation engineering and hydraulics, died recently at his home. Mr. Parshall was well known among the irrigation and reclamation people of the West.

One of his best known accomplishments was the design for the "Parshall flume." Although it was first brought into use 30 years ago, it is still the legal standard for measuring the distribution and control of water in countries throughout the world. He has been associated with the Colorado State University in hydraulics and irrigation engineering for half a century. Since 1918 he served as director of that department. #

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the ERA that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

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MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5206	Colorado River Storage, Ariz.-Utah.	Feb. 15	Construction of parking area and utilities for Block 17 at Page, Ariz.	A. J. Kelton, Contractor, Phoenix, Ariz.	$111,535
DC-5238	Fort Peck and Missouri River Basin, N. Dak.-Mont.	Jan. 5	Stringing conductors and overhead ground wires for 310 miles of Fort Peck-Dawson County-Bismarck 230-kv. transmission line.	Hoosier Engineering Co., Columbus, Ohio.	3,080,053
DC-5247	Missouri River Basin, S. Dak.	Feb. 17	Construction of Stage 03 additions to Huron substation for the initial 230-kv. development.	Gustav Hirsch Organization, Inc., Columbus, Ohio.	197,400
DC-5254	Columbia Basin, Wash.	Jan. 8	Construction of earthwork, concrete lining, and structures for Block 88 laterals, wasteways, and drains, West canal laterals.	Lewis Hopkins Co., Pasco, Wash.	667,358
DC-5256	Gila, Ariz.	Jan. 14	Construction of earthwork, concrete lining, and structures for Wellton-Mohawk main conveyance channel, Stage 0–23.31 to 1176+65BK.	Peter Kiewit Sons' Co., Arcadia, Calif.	2,183,554
DC-5258	Middle Rio Grande, N. Mex.	Jan. 19	Channelization of the Rio Grande, Belen Area, Unit 4.	Allison and Haney, Inc., Albuquerque, N. Mex.	558,552
DS-5260	Colorado River Storage, Ariz.-Utah.	Feb. 12	2 300-ton traveling cranes and 1 set of lifting beams for Glen Canyon powerplant.	Yuba Consolidated Industries, Inc.; Yuba Manufacturing Division, Benicia, Calif.	385,600
DC-5264	Gila, Ariz.	Mar. 1	Construction of earthwork, concrete lining, and structures for Wellton-Mohawk main conveyance channel, Stage 1183+97.77AH to 2377+05AH.	Marshall and Haas, Belmont, Calif.	1,422,720
DC-5268	Missouri River Basin, Nebr.	Mar. 22	Construction of earthwork and structures for Culbertson extension canal, Stage 1719+00 to 2571+36, and laterals, wasteway, and drains, Schedules 1 and 2.	Ralph W. Forkner and Heide-Christolear, Inc., Clay Center, Kans.	1,356,515
700C-506	Missouri River Basin, Kans.	Mar. 15	Construction of earthwork and structures for Pump No. 1 Canal and Pump No. 1 South Canal and lateral system, including pumping plant and discharge lines.	Bushman Construction Co., St. Joseph, Mo.	250,542

Major Construction and Materials for Which Bids Will Be Requested Through June 1960*

Project	Description of Work or Material
Central Utah, Utah	Constructing the Fort Thornburg diversion dam consisting of compacted earth dikes and a rockfill overflow spillway with concrete corewall, constructing 2 reinforced-concrete headworks structures with radial gates, and earthwork and structures for about 3 miles of Stanaker feeder canal.
Central Valley, Calif.	Constructing the 3,500,000-cubic-yd. earthfill Whiskeytown dam, 298 ft. high and 3,200 ft. long, and appurtenant structures. On Clear Creek, about 9 miles west of Reading.
Do	Constructing the indoor-type Trinity powerplant and tailrace and the indoor-type Clear Creek powerplant, penstock, and tailrace. The Trinity powerplant will be located about 32 miles northwest of Redding, and the Clear Creek powerplant will be located about 18 miles northwest of Redding. (To be issued as separate schedules in 1 specifications.)
Do	Constructing the Stone Corral pipe distribution system consisting of about 25 miles of pipe varying in sizes of from 6 to 30 in., and 7 small pumping plants of 5-c.f.s. capacity and 4 moss-screen structures with traveling water screens. Near Visalia.
Do	One 350-ton traveling crane bridge with 1 175-ton trolley for Spring Creek powerplant; 1 300-ton traveling crane bridge with 1 125-ton trolley and 1 175-ton trolley for Clear Creek powerplant; and 1 250-ton traveling crane bridge with 1 75-ton trolley for Trinity powerplant. Total estimated weight: 1,030,000 lbs.
Do	2 200-r.p.m., vertical-shaft, Francis-type hydraulic turbines, including 2 interchangeable runners for each turbine, 1 runner rated 85,000-hp. at 426-foot-head and the other rated 70,000 hp. at 334-foot-head, for Trinity powerplant.
Do	Two 93,500-hp., 225-r.p.m., 514-ft.-head, vertical-shaft, Francis-type hydraulic turbines for Clear Creek powerplant.
Do	4 steel penstocks consisting of 2 10-foot 6-in.-diameter penstocks, each about 2,100 ft. long, including 1 wye-branch; 1 11-ft.-diameter penstock about 135 feet long; and 1 11-ft.-diameter penstock about 175 ft. long. Clear Creek and Trinity powerplants.
Colorado River Storage, Ariz.	23 fabricated steel stoplog sections, 1 lifting frame, and 8 sets of cast-iron and steel guides for Glen Canyon Dam. Total estimated weight: 1,595,400 lbs.
Do	4 96-inch hollow-jet valves for Glen Canyon Dam. Total estimated weight: 550,000
Colorado River Storage, Ariz.—Continued	24 12-ft. 5-in. by 15-ft. 11.375-in. fabricated steel bulkhead gates with seats and guides and 1 lifting frame for Glen Canyon powerplant. Total estimated weight; 555,300 lbs.
Crooked River, Oreg.	Constructing a reinforced concrete headworks structure, a fish screen structure with a 14-ft.-long by 9.5-ft.-diameter revolving drum screen, and earthwork and structures for about 3 miles of earth-lined canal, 0.8 mile of gravel-lined canal, and 3.7 miles of unlined canal. Diversion canal, near Prineville.
Do	Earthwork and structures for about 15 miles of 9- to 2-ft. bottom width unlined Distribution canal, near Prineville.
Do	Constructing the outdoor-type, reinforced concrete, flat-slab Barnes Butte pumping plant with 4 horizontal, centrifugal-type pumping units having a total capacity of 115.5 c.f.s., and constructing intake and discharge lines and a switchyard; constructing the outdoor-type Ochoco relift pumping plant with 3 pumping units having a total capacity of 66 c.f.s., a feeder canal discharge lines, and switchyard. Near Prineville.
Hammond, N. Mex.	Constructing about 6 miles of Hammond Main unlined canal including 6 60-in.-diameter siphons and a 60-in.-diameter cut and cover section on which alternate bids for precast concrete pipe or monolithic concrete construction will be requested. Near Farmington.
Klamath, Calif.	Constructing about 4 miles of earth-lined canals and laterals, 3.5 miles of drains, and deepening about 2.5 miles of existing drains. Sump 2 (Contract Unit 2). Near Tule Lake.
Lower Rio Grande, Tex.	Earthwork and structures for rehabilitating about 5.6 miles of "K" which will consist of reshaping the prism and banks, constructing unreinforced concrete lining in the new section, and constructing about 1.1 miles of 36-in. pipeline. Near Mercedes.
MRB, Kans.	Constructing a reinforced concrete high-pressure gate control house and pressure chamber and about 600 ft. of 66-in.-diameter concrete pressure pipeline with open transition to an open canal. Cedar Bluff dam, near Ellis.
MRB, Nebr.	Constructing the Arcadia diversion dam will include constructing a radial-gate-controlled spillway section about 400 ft. long, a radial-gate-controlled headworks structure for Sherman feeder canal, about 7,300 feet of canal including a settling basin about 2,000 ft. long, 150 ft. wide and 15 ft. deep. Near Comstock.

*Subject to change.

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REGIONAL OFFICES

REGION 1: Harold T. Nelson, Regional Director, Box 937, Reclamation Building, Fairgrounds, Boise, Idaho.
REGION 2: Hugh P. Dugan, Regional Director, Box 2511, Fulton and Marconi Avenues, Sacramento 11, Calif.
REGION 3: A. B. West, Regional Director, Administration Building, Boulder City, Nev.
REGION 4: Frank M. Clinton, Regional Director, 32 Exchange Place, P.O. Box 360, Salt Lake City 10, Utah.
REGION 5: Leon W. Hill, Regional Director, P.O. Box 1609, Old Post Office Building, 7th and Taylor, Amarillo, Tex.
REGION 6: Bruce Johnson, Regional Director, 7th and Central, P.O. Box 2553, Billings, Mont.
REGION 7: John N. Spencer, Regional Director, Building 46, Denver Federal Center, Denver, Colo.

The Reclamation Era

AUGUST 1960

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The San Angelo Story
Radiological Monitoring in Reclamation

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The Reclamation Era

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In this issue . . .

J. J. McCARTHY, Editor

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take a good look at Sprinkler Irrigation

In a recent address before the Sprinkler Irrigation Association Open Conference in Chicago, Assistant Commissioner William I. Palmer of the Bureau of Reclamation stated "We are going to need progress in farming as we have never known it before if we are to keep pace with our needs." The Assistant Commissioner pointed out that within 50 years our population will double while harvestable cropland will be reduced to approximately 1 acre per person and that water as well as land is going to be scarce despite all that is being done to rebuild soil and conserve our water supply.

In the United States where not more than 10 percent of the working population is currently engaged in farming and where the numbers of farms and farmers grow smaller year by year, the need for agricultural automation is as real as the dual necessity for water and soil conservation.

The sprinkler irrigation industry, perhaps more than any other segment of industry producing equipment for agriculture production, offers basic farming tools that by their very use insures water and soil conservation as well as more efficient use of available agriculture man-hours.

Yet, too often those charged with planning the development of idle lands and the conservation of land and water resources overlook or fail to recognize sprinkler irrigation as the conservation tool that comes closest to meeting conservation objectives in bringing potentially fertile, idle land into production and providing water for that land.

With few exceptions, sprinkler irrigation can put the right amount of moisture for a given crop on even rolling terrain and uses only 75 percent as much water as is required by other irrigation methods even on level land. Actually, sprinklers could irrigate, with maximum efficiency, one-third more land than is currently being irrigated by other methods without increasing present water consumption.

The sprinkler approach to applying water to reclaimed lands requires only that the land be cleared and suitable for tillage. It eliminates the need for costly leveling or changing the contour of the land to accommodate a gravity flow of water. In short, sprinkler irrigation can be engineered to the requirements of the land rather than altering the land to make it conform to an irrigation method.

In this era of scientific farming, sprinkler irrigation provides a method of applying water that offers results based on the capability of engineered equipment rather than the irrigation skill of itinerant or casual labor. It has long been recognized that surface irrigation is only as efficient as the man who handles the shovel. Even at best, irrigation by hand can only *approach* the efficiency of water utilization, the evenness of application and the increased yields and crop quality that are expected with sprinklers.

Sprinkler irrigation is sometimes defined as "controllable rain with built-in irrigation efficiency." Assuming basic water availability, whether it be from ditches, ponds, lakes, rivers and streams or wells, sprinkler irrigation provides the farmer with his own "private" rain. It is controlled "rain" in every sense of the word—"rain" that can be turned on and off as the farmer wills

by E. HOWARD CLAYPOOLE, Managing Director, Sprinkler Irrigation Association, Los Gatos, Calif.

Hill or dale—it's all the same when sprinklers handle the application of water to cropland. *(Sprinkler Irrigation Association photos.)*

rather than according to the whims of nature—"rain" that applies predetermined amounts of moisture at the right time to the right crops at the most efficient rate of application.

Automation, a term and a practice long associated with industry is becoming more and more a factor in agriculture. Less labor is available each year to help farm more acreage. Sprinkler irrigation more than any other irrigation approach, can apply the principles of automation to the application of moisture.

The sprinkler irrigation industry now offers completely automatic systems, a variety of power wheel systems, self propelled units, minimum-manpower and fast-assembly portable systems and the ingenuity to tailor a system for water application to the labor availabilities, crop and soil water requirements and/or limitations that insures maximum utilization of available manpower, water, and equipment. One automatic system, operating on the lateral line individual sequence principle, can be left unattended for extended periods with assurance that crops will be watered regularly at intervals preset on the master control. All automatic systems offer around-the-clock utilization of available water without the need for day and night labor shifts.

Powered lateral move wheel systems have been equally improved. Wheel diameters have been increased to the point where most field crops can be irrigated by one man operating a number of powered lines, each one-fourth mile long. Tow systems are also contributing laborsaving methods for the irrigator. System moves, involving multi-

ple lengths of tubing, can be made from row to row in minimum time.

Within the past year, a sprinkler manufacturer has developed a water application method known as aeration irrigation. It is irrigation by sprinklers with low application rates (approximately one-half of the normal intake of the soil) combined with good nozzle pressure. Sets are twice as long as heretofore considered normal. Advantages gained include improved soil structure and elimination or prevention of soil compaction. These results have been found on various crops and numerous types of soil. Greater yields and more top quality products are being reported when this application method is combined with other sound irrigation practices.

Farmers operating in the "Frost Belt" of the United States are finding sprinkler irrigation systems provide a secondary farming function that can minimize, if not eliminate, one of the prime hazards of agriculture in the Temperate Zone.

Every year, millions of dollars in crops are completely destroyed or yields reduced to an unprofitable level as the result of killing frosts. Whether they occur early in the growing season or late in the year when the last tonnage of yield can make the difference between a modest return or a substantial profit on the season's labor, the result is the same. Income from frost damaged or destroyed crops is irrevocably lost—and it never can be replaced.

Today, progressive farmers with sprinkler irrigation systems are protecting row crops, orchards, and vineyards from unseasonable weather and the inevitable damage from frosts by protecting them with water applied through sprinkler irrigation systems.

Working on the heat transmission principle—since ice is formed by removing heat from water—a fine spray is sprinkled on all exposed plant, tree, or foliage surfaces. When air temperature reaches 32°, the water freezes to form a coating of ice. The water's natural heat (144 B.T.U.'s per pound) transfers to the foliage or fruit as the ice forms, protecting the crop with a simple but effective "natural heater" that operates as long as water is being applied and ice continues to form.

By continuing to sprinkle until the ice melts as the result of the air temperature rising to above 32°, the "reverse" transfer of melting ice absorbing heat from the plant is eliminated and the crop emerges unscathed.

Currently, in Michigan alone, more than 5,000

Lateral move wheel line powerplant here has 5-foot wheels, but new systems use even larger.

Sprinkler system irrigating young corn which is planted on land that slopes substantially.

acres of strawberries as well as substantial acreage of tomatoes and peppers are receiving sprinkler irrigation frost protection. Hundreds of orchards and vineyards throughout California continue to emerge unscathed from what formerly would have been high casualty catastrophes.

A California vineyard operator in the Coachella Valley, where grapevines give the impression of being evergreens and daytime temperatures average well above 70°, found that sprinkler protection afforded during one cold spell in November 1958 proved the worth of an elaborate and extensive system in which they had soundly invested more than $175,000.

For many citrus-grove owners, all night frost guard vigils and smudge pot drudgery are already things of the past and the surrounding community rests in smudge-free comfort—thanks to automatic controls that turn on sprinkler systems when grove air temperatures approach the critical point and keep them operating until the ice coverings they form have melted away.

Mounting concern over water shortages and fertilizer application costs has created widespread interest in fertilizer-moisture relationship. More and more attention is being paid to a coordinated use of water and fertilizers—two of the most important factors in crop production.

The resulting utilization by the modern farmer of fertilizers, plant or soil nutrients, and herbicides in liquid or water soluble form, has brought sprinkler irrigation into prominence in another phase of agriculture automation.

Intensive field investigation and realistic research by the National Plant Food Institute have shown that applying fertilizers through sprinkler irrigation systems results in labor plus money saving advantages and in less compaction of the soil due to having to make fewer trips over the field. Nitrogen, for example, lends itself ideally to sprinkler application since it can be applied at anytime during the growing season. Irrigators are combining an irrigation setting and a fertilizer application in a single operation.

Even potash and phosphate, which have to be put in the soil, lend themselves to sprinkler application and the simultaneous, dual use of sprinkler equipment. In the area where preirrigation is required or advisable, those farmers are performing three soil preparation steps into two by preirrigating and applying potash and/or phosphate in one operation and then plowing it into the soil.

An increasing interest in foliage fertilization, supplemental to soil applications, has resulted

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Reclamation's HALL OF FAME Nomination No.22

"Utah, the West, and the Nation acknowledges the ability you have demonstrated in developing and conserving the lifeblood of agriculture and industry in our great inland empire. Yours has been literally a life of scientific improvement of our significant resources. Modestly, quietly, yet courageously you have pursued and employed both your talents and those available in manpower and science to bring new and vigorous life to the mountain West." Thus began a citation wherein Ole received from his alma mater, Utah State Universtity, an honorary degree of doctor of science in 1949.

Citations have become quite common to Utah's native son. He received also from his alma mater its distinguished service award in March 1956; the National Civil Service League conferred upon him its merit citation in September 1956; he was given a distinguished service award in April 1959 by Utah's Federal Business Men's Association; and in April 1957 the Department of the Interior conferred upon Ole a citation for distinguished service, its highest award.

Ole looks back with pride to the many successful reclamation projects which exist because of his sharp vision, enthusiastic leadership, and effective promotion. Utah was particularly fortunate in seeing the works of Ole blossom and bear fruit. Among these are the Strawberry Valley, Weber River, Ogden River, Hyrum, Moon Lake, Sanpete, Scofield Dam, Newton, Weber Basin, and the Provo River projects.

Designated as Director of the Bureau's region 4 in 1943, Ole was put in charge of many other projects and investigations in the Upper Colorado, Bonneville, and Lahontan basins where river compacts and cooperative basin plans were neces-

by C. B. JACOBSON, Chief, Upper Colorado River Office, U.S. Bureau of Reclamation, Salt Lake City, Utah

sary to maintain and foster the economy of the region. His intimate knowledge, enthusiasm, and authoritative counsel was readily accepted with gratitude by water users in those parts of Utah, Colorado, Wyoming, New Mexico, Arizona, Idaho, Nevada, and California. Culminating an engineering career of over 40 years, Ole placed the monumental Colorado River storage project and its participating projects well underway before retiring from the Federal service on March 1, 1960.

Affectionately referred to as the "Swede" from Santaquin, a village at the time of his birth in 1894 destined to become a part of the Strawberry reclamation project, Ole in his early years witnessed his father's crops wither on water-starved land but later take life through the project's transmountain diversion and high line canal. This transition helped establish Ole's main goal—that of making the farmers independent of the weather.

In those days the cayuse was the accepted mode of travel and "plinking" at coyotes with a 30–30 rifle over the 6-mile route to the Payson High School was more than pastime play since pelts and bounties helped defray Ole's school expenses. Vacationing in the summer on the farm and in the mines set Ole scheming for better and more efficient ways of getting jobs done. This was real grassroot training for one who would devote himself to the development of water for power and irrigation. Even the pair of drumsticks providing rhythm for the town of Logan and tuition during his college days made their mark, for ever since Ole graduated in 1918 as an irrigation and drainage engineer, watershed after watershed has responded to his beat and pounding for efficient and best use of nature's resources.

He began his professional career as a hydrographer for the water users on the Logan River. The next few years provided Ole with a background of irrigation and drainage experience on both sides of the Utah-Idaho border with the Department of Agriculture. He also assisted in the agriculture, irrigation, mining, and manufacturing 1920 census.

Desiring further improvement in his technical ability, Ole returned to college as an assistant in the Extension Division and earned a master of science degree. In June 1923, as an instrument man, he began an uninterrupted career of almost 37 years with the Bureau of Reclamation.

"Ole," who began long career with Bureau as instrumentman, is amused by trick rubber sliderule.

Advancing through the grades of junior and assistant engineer, Ole in 1927 was placed in charge of Salt Lake Basin investigations. Through Ole's pleading and prodding, in spite of the hectic economy that followed, Utah came up with an amazing slate of reports and plans for a dozen or more reclamation projects. These took root in the depression years giving employment to many of the Bureau's hard-pressed construction engineers. The construction of his pride and joy, the Provo River project, however, was reserved to Ole in 1938.

In October 1943, the Bureau undertook a major reorganization and the helm of region 4 logically went to Ole Larson. He gave distinction to this office for over 17 years and was considered dean of the Regional Directors, serving longer than any of the original seven.

The directorship was more than a full-time job. Yet, at the same time other duties were piled upon Ole. He was appointed by the President as United States representative and Chairman of the Bear River Compact Commission. He represented the Department of the Interior on the Pacific Southwest Interagency Committee and took his turn as Chairman. Likewise, he served on Interior's Field Committee. He was Interior's liaison officer for civil defense in the western area. In addition, he found time for civic activity, being an active member of the Salt Lake Kiwanis and Alta Clubs.

Ole's character is studded with practical optimism, persuasiveness, and enthusiasm. He speaks equally convincingly to legislators or irrigators. They say, " * * * he takes a dream, clothes it in

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Lake Owyhee
the Sportman's Oasis

"Let's go fishing!" This is the cry heard up and down Treasure Valley the first warm days of the early spring. The farmer on his irrigated farm, the workman at his machine, and the professional man in his office, all start thinking of Owyhee Lake and wondering if the crappies have started biting. Treasure Valley is that portion of the Central Snake River Valley in Idaho and eastern Oregon created by the irrigation of 500,000 acres of fertile soils supporting a population of 275,000 people.

In this, our 10th year of the boating boom, a thousand or more boats and outboard motors are being readied for another recreational year by sportsmen who have discovered the irrigation storage reservoirs provide more and better fishing. Among these reservoirs, Owyhee Lake is best noted for its crappie and bass fishing.

Construction of the Owyhee Dam was completed in 1932 by the Bureau of Reclamation to store irrigation water for use on the 100,000-acre Owyhee project. The dam, standing some 325 feet above the former river level, created a lake 53 miles long in a narrow gorge cut haphazardly through the rough Owyhee hills which had been created ages ago by volcanic activity. The walls

by PAUL HOUSE, Manager, North Board of Control, Owyhee Project, Nyssa, Oreg.

Boating on Lake Owyhee, which extends for 53 miles in gorge whose walls rise to 2,000 feet above lake surface.

of the gorge, composed of rocky cliffs and steep inclined slopes, rise 2,000 feet above the lake surface. The area is devoid of trees—the principal vegetation being sagebrush and grasses. As the dam is also used for a diversion dam, diverting the irrigation water through a tunnel 230 feet above the old river level, the lake will of necessity never be less than 230 feet deep.

Prior to construction of the dam, hot springs which occur in several places along the river made the water too warm for good fish habitat, but the water impounded in the reservoir, mostly as a result of the snowmelt on the upper reaches of the watershed, remains about 50° F. the year round. Crappie and bass planted soon after construction of the reservoir increased phenomenally. The lake is inaccessible by road, except by the road to the dam. Few fishermen have been able to fish the upper reaches unless they had boats. The waters, therefore, began to become overstocked with fish. As a result, the reservoir is open to year-round fishing, and until this year, no limit was set on the number of crappie or bass which could be taken from the reservoir. In 1960, a bag limit of 12 bass a day, of which not more than 5 may be 17 inches or over in length, has been set by the Oregon Game Commission. There is no bag limit on crappies.

With the beginning of the warm days in April, and continuing through May and June, it is possible some days to catch crappie by the gunnysack full. On these days, almost any type of lure dropped into the water will attract a large number of fish, and should one get off the hook before the line can be reeled in, another fish will grab it. Other days, the fish may seem to have almost disappeared, and only a few will be caught with a hard day's fishing.

The bass are even more unpredictable. Lacking lily pads and logs, they are usually found around the rocky reaches of the lake and seem to move in schools at times as the crappies do. Sometimes as the cliffs begin to throw the shadows across the water in the late evening of a hot summer day, the bass will begin to feed and, for possibly an hour, a bass will strike on every third or fourth cast. Then, as suddenly as they began feeding, the action will cease. Strangely, few small bass are ever caught with the usual size running from 3 to 6 pounds.

In the fall and winter months, Owyhee Lake becomes a resting place for thousands of ducks and geese on their annual migration south. During the summer and fall, deer also come down to this huge body of water in the evenings or early mornings to slake their thirst. Hunting has been somewhat limited due to lack of access roads.

The only road, other than four or five jeep trails, is a graveled road from Nyssa, Oreg., up the Owyhee Canyon to the dam, and then up the lake to Cherry Creek Landing. Excellent facilities, including cabins, a restaurant, and a boat landing, have been developed at Cherry Creek. Along the lake, between the dam and Cherry Creek, the State of Oregon is developing camping areas.

More and more hunters are using the lake as a means of reaching some of the wilder areas near the upper end of the lake. It is not at all unusual for the hunters to spend the early morning hours hunting deer and the rest of the day fishing the upper reaches of the reservoir with good success.

Others, not haunted by the fish, use the lake for water skiing, sightseeing, and picnicking, or as an avenue to the agatized rock found in the multicolored cliffs.

All this has resulted from the prosperity created by the fulfillment of the dreams of a few men of vision who were determined to build a dam to hold back the spring runoff of the melting snows and convey the waters as needed and required to thirsty acres of rich desert lands, thus providing a bountiful harvest. # # #

The San Angelo Story

by J. N. GREGORY, Geologist, and Secretary-Treasurer of the San Angelo Water Supply Corporation

Progress doesn't "just happen." People with vision make it happen. The people of San Angelo, Texas, a beautiful city of about 60,000, were not content to watch their community "wither on the vine" for the lack of water. What they did about it can be seen as a multiple-purpose dam at Twin Buttes site goes into construction. No longer will the city be limited because of a lack of water, but can look forward to growth, progress, and a bright future.

The progress that didn't "just happen" is the result of vision and leadership of progressive citizens led by Mr. M. D. Bryant. It was while Mr. Bryant was Mayor of San Angelo that water shortages plagued the city, and in 1955 the Bu-

Commissioner Dominy (standing) opens first bid for construction of Twin Buttes Dam, San Angelo project, Texas.

reau of Reclamation was asked to study the problem and recommend a solution.

With information made available to him, he led the way in exploring every phase of water and land resource development. As a result of these studies and his continuing efforts, the San Angelo Water Supply Corp. was formed and has contracted with the Government for the construction of the Twin Buttes Dam, about 9 miles southwest of the city. With this assured water supply, the city can plan many new and wonderful things to provide the greatest good to the greatest number of citizens of the San Angelo area.

The Twin Buttes Dam will be about 8 miles long and will trap and store the flows of the Middle and South Concho Rivers, and Spring Creek just upstream from Lake Nasworthy, one of the city's present sources of water. The contract for the dam and related works has been let to the H. B. Zachry Co., the low bidder, for $11,-836,428, and construction has started. Through the intergrated operation of Twin Buttes Dam and San Angelo Reservoirs and Lake Nasworthy, an annual water supply of 29,000 acre-feet will be available for the city, and up to 25,000 acre-feet for irrigation. Twin Buttes Dam will also provide for flood control, fish and wildlife and recreation, and permit stabilization of the water elevation in Lake Nasworthy, greatly enhancing its value and beauty as a park and its shores as a residential area.

Initiation of construction on the Twin Buttes Dam was a signal for the start of an endless flow

President Eisenhower inspects parched field during trip to drouth-stricken Texas, New Mexico, Oklahoma, in 1957.

President meets farm families during drouth inspection trip. ***(Photos this page, Abbie Rowe, National Park Service.)***

of benefits that will result from construction of the San Angelo project. This first noticeable effect came to town in the form of new employment opportunities, new families, and new payroll checks. Benefits from this construction phase will last about 4 years, during which time it is estimated that about $11 million will be dispersed within the local area for wages paid to construction workers, the purchase of local building materials, and for fuel and oil for construction equipment. The major portion of this expenditure will be for hired labor. Their wages will largely be spent within the local area for food, housing, clothing, recreation, and many other items needed to satisfy man's wants. In addition, lòcal expenditures for right-of-way, relocation of highway and railroads, and other items will total about $6 million. A welcome boom for San Angelo merchants! As activity within the local area increases due to increased sales, this activity, like a ripple caused by a rock thrown into a pond, will spread out to other regions of the State and into other States. Many manufacturing and industrial centers, wholesalers, and transportation concerns will feel the impact from supplying a stimulated market in San Angelo.

In addition to the impact from expenditures within the local area, about $12 million will be spent for nonlocal items including lumber from the Pacific Northwest, steel from Ohio or Pennsylvania, machinery from the Great Lakes area and cement from Texas. In addition, many other States will ship some material or equipment for the project's construction. These items will be

At Twin Buttes Dam bid opening, left to right, Commissioner Dominy, G. R. Rolin, A. A. Lewis, and H. S. Kerr.

purchased from many of the manufacturing and industrial centers of our Nation. Transportation companies too, will benefit from the movement of construction equipment and supplies from the place of purchase to the construction site.

Upon completion of the project, the second and more permanent-type benefits will begin to be realized. These benefits will come from the use of municipal and industrial water; from irrigation of often thirsty cropland; from flood control of storm swollen streams; and from the outdoor activity provided by fish and wildlife and recreation facilities. The impact of municipal and industrial water upon the city of San Angelo is the most dynamic attribute of the project. The need for water resource development had been recognized for many years, and lack of adequate water could have been a limiting factor to growth of the city. Provision of adequate water supplies will assure its growth for at least the next 50 years. Population projections for the city, based on an adequate water supply, together with other resources of the area, indicate that the city will grow from a present population of about 60,000 to 140,000 over the next 50 years.

Studies made to determine the impact of municipal and industrial water development upon an area, indicate that where there is a demand for water, and water is provided, that it will result in growth of an area. For the San Angelo trading area, it is anticipated that for each 1,000 acre-feet of new municipal and industrial water supplied and used, there will be new employment opportunities for 460 persons and new annual income of $1,825,000. The water demand for the city of San Angelo is expected to increase from 17,000 to 29,000 acre-feet during the 45-year repayment period, or a total increase of 12,000 acre-feet The average increase in water demand will amount to about 6,000 acre-feet over the 45-year period. This increased demand for water of 6,000 acre-feet will result in new employment for 2,800 persons and bring new income to the area amounting to $10,800,000 annually. The employment and income realized in the San Angelo trading area will, in turn, affect other regional trading and manufacturing areas of the State and Nation.

Mr. Bryant and other city leaders, realizing the economic advantage of a prosperous agriculture in the trade area and wishing to fully utilize the precious water supply, have provided for irrigation of 10,000 acres of land around the town of Veribest, about 10 miles east of San Angelo. Farmers and urban leaders were anxious to spread the benefits of the project to as many citizens as possible. They agreed that no farmer would receive irrigation water for more than 110 acres, making it possible to spread the benefits of irrigation to about 100 farm families. This will help each farmer have a higher income and create more benefits to the city. The Tom Green County Water Control and Improvement District No. 1 will operate the irrigation distribution works and will repay $4 million of the reimbursable costs of the project. The remaining reimbursable costs of the project will be repaid by the San Angelo Water Supply Corp.

Irrigation water for farmlands of this area will be a wonderful asset, as farmers have been faced with the hazard of drought from the time their land was first settled. Drought has frequently caused agricultural production losses even to complete crop failure. The stabilizing effect on the area brought about by irrigation will be clearly evident, both on the project farms and in the surrounding area. During extreme drought periods, the liquidation of range livestock breeding herds on ranches in the vicinity of San Angelo will be held to a minimum. This will be made possible by the assurance of feed crops on nearby irrigated land.

The benefit to farm income derived from irrigation is estimated by studies of the area. These studies indicate that annual net farm income will be increased from $22 to $64 per acre. The total annual increase for the 10,000 acres of irrigated

land, after full development, will amount to about $417,000. This increased income will be derived principally from the following crops: Cotton, grain and forage sorghum, alfalfa hay, and oats. In addition to the increased income received by farmers, there will be an accompanying benefit to the San Angelo trade area, to the remainder of the State and to the Nation, in transporting, processing, and marketing the increased farm production, and in supplying the new demand in the local area for producers' and consumers' goods. Studies made of a similar area, to determine the impact due to irrigation development, indicate that for each $1 of new net farm income, an additional $3.20 accrues as personal labor income to the trading area center. To the city of San Angelo and the surrounding trade area, this could mean a new income of $1,335,000 annually and new employment for 380 persons.

Other purposes of the project also provide substantial benefits to the trade area, and, in turn, will cause a favorable impact upon the economy of the State and the Nation. Annual direct benefits to the trading area from these three purposes are as follows: Flood control, $400,000; fish and wildlife, $307,000; and recreation, $30,000.

The total evaluated impact of this water and land resource development upon the San Angelo trading area amounts to an income of about $13 million annually and employment for 3,180 persons. This annual income indicates that beneficial effects of the project will equal the construction cost about every 2 years.

In San Angelo, left to right, Commissioner Dominy, Leon W. Hill, Grant Bloodgood. ***(Except as noted, preceding photos by J. M. Dickerson, Bureau of Reclamation, region 5.)***

A partial measure of the project's worth to the Federal Government can be analyzed by the increase in Federal income taxes that would come from the San Angelo area due to project development. These taxes have been estimated at $1,431,000 annually, and would be equivalent to the cost of the project in about 20 years. This income would be in addition to the reimbursable construction costs paid by the San Angelo Water Supply Corp. Carrying the impact of the project beyond the San Angelo area will prove only more conclusively the worth of the project to the State of Texas and to the Nation.

M. D. Bryant, leader in San Angelo, who has worked tirelessly in support of the San Angelo project.

Mr. M. D. Bryant was born August 25, 1895, at Longstreet, La. In World War I, he served in the U.S. Army, Signal Corps. He married Ethel Christian September 19, 1919, and they became parents of two girls and a son. The son was killed in World War II.

Since his early years, M. D. Bryant has been associated with the oil business, both as a wildcatter, and as an oil producer. Shortly after the discovery of oil in the Permian Basin of Texas and New Mexico in May 1924, Bryant and his family moved from Luling, Tex., to San Angelo where he and his wife still reside. San Angelo at that time was the center of oil development in the Permian Basin. He had his share of both the ups and downs that invariably go with the oil business. He played his part in development of oil in the east Texas oilfield, and this was followed with an oil strike in Pecos County, Tex., and then another in the Illinois Basin.

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prevention of water weeds

The following information is based on an article appearing in the April 1960 issue of *Irrigation Engineering and Maintenance* by C. George Green, who is a technologist for Shell Chemical Company, a division of Shell Oil Company.

Ask a big farmer in the West where he gets water for his crops. "I just phone for it," will be his immediate reply. To the irrigation district manager, the task of wetting the roots of the farmer's plants isn't that simple. Moving large volumes of water from a river or storage reservoir through an intricate system of canals and delivering it on time at an economical cost is rather complex business. Many problems and much water loss can occur between the reservoir and the farmer's headgate.

One major problem in the movement of water by an irrigation district is the loss of the water-carrying capacity of a canal system due to water weeds. Every year water weeds, commonly known as "moss," reduce the operational efficiency of many canal systems and in extreme cases cause crop failures. The cost of raising a crop of submersed weeds in a canal is high, but the cost of harvesting the crop mechanically is phenomenal. Why raise "moss" in an irrigation canal?

The need for an aquatic herbicide, more economical than chaining and more versatile than aromatic solvents, has been apparent in irrigated farming areas for quite some time. After several years of laboratory and field testing in the irrigation and drainage areas of the United States the acrolein herbicide process has been developed for the control of undesirable submersed aquatic vegetation. The process involves not only a specially formulated chemical but also a unique application technique.

The chemical used in this process (formerly designated as F–98) is a specially stabilized spontaneous dispersing formulation of acrolein. Although quite volatile, the acrolein herbicide is instantly water soluble and through the use of special application techniques can be handled with ease. When the material is applied correctly, in water, it will (1) control submersed weeds for relatively great distances—over 25 miles in one case—in moving streams, (2) control weeds at rather low concentrations—3 to 6 p.p.m.—in lakes and static reservoirs and (3) cause weeds to disintegrate, eliminating the necessity for mechanical removal.

All typical submersed aquatic weed species and algae appear to be susceptible to the acrolein herbicide (Potamogeton, Najas, Zannichellia, Ceratophyllum, Spirogyra, and others). Floating forms such as water cress, water hyacinth, and water primrose can be controlled, but at a dosage rate slightly higher than that required for submersed species. Emergent species such as cattails and tules are not affected.

Acrolein herbicide is a general cell toxicant and kills through its sulfhydryl reactivity, which destroys vital dryl reactivity, which destroys vital enzyme systems in the plant cell.

Numerous phytotoxicity studies have been conducted in which treated water was applied to crops by furrow, flood, or sprinkler irrigation. When toxicity occurred, it resulted from actual contact of tender crops with the solution, as in flood irrigation, or by vapor action. Many fac-

atory animals and lactating animals, no adverse effects were observed and no milk contamination occurred when it was added to the drinking water at levels far in excess of those that would be encountered under any conditions of use. A maximum of 600 p.p.m. was administered to laboratory animals in these toxicity trials; the normal level for weed control is from 3 to 40 p.p.m.

Field observations and laboratory data show that fish vary considerably in their tolerance to acrolein herbicide. Carp and thread-fin shad are particularly sensitive, being killed at 1–2 p.p.m. Black bass, blue gill, and lamprey eel larvae appear to tolerate up to 5 p.p.m. Through special

Before and after chemical applied to eradicate water-stealing weeds that reduce the operational efficiency of many canals. *(Shell Oil Co. photos.)*

tors, such as wind, temperature, crop species, etc., influence the results. Therefore, until more data are obtained, the concentration of acrolein herbicide in water contacting crops should not exceed 15 p.p.m.

Toxicity tests on laboratory animals show that the compound, in its pure concentrate state, is relatively toxic to mammals. While highly lachrymatory, it is not an insidious chemical nor is it hazardous to use. In feeding tests with labor-

application techniques fish can be chased and/or herded without injury for selective elimination of rough species from game species.

From samples of lake bottom fauna organism taken prior to and after treatment, with dosages up to 12 p.p.m., it was found that acrolein herbicide had no effect on the organisms present (Chironomid, Ceratopgonid, Tuberficid, Chaoborus and Tanypus).

(Continued on page 82)

The annual "crop report" for 1959 shows that new additions to the reclamation service area, together with generally higher yields and higher prices for some crops, edged the value of crops grown on reclamation projects in 1959 above a billion dollars for the first time. Net additions to the irrigated area amounted to 42,014 acres, bringing the total irrigated land to 6,798,751 acres. The total land to which service is available amounts to 8,094,383 acres.

The production from four new projects now in operational status are included in the report for the first time. There are Little Wood River, Idaho; Solano, Calif.; Santa Maria, Calif.; and Ventura River, Calif. These projects, when fully developed, will provide irrigation service to about 158,000 acres.

Irrigators reported an average crop return of $164.23 per acre. The average return from crops on the 129,000 reclamation farms amounted to over $8,600 per farm. These crops values represent the total farm value of commodities sold or consumed on the farm. No estimate was made of net farm receipts.

Fruits and nuts continued to be the highest value crops, averaging out at $553 per acre, although individual crops exceed that amount in many cases. Bringing in more than a thousand dollars per acre were celery, dates, cucumbers, tomatoes, and berries. Nursery items brought farmers an average of $2,387 per acre.

Nearly 5 million tons of vegetable crops were harvested, representing 20 percent of the total crop value from the use of only 8 percent of the irrigated land.

One-third of the crop value was realized from the miscellaneous field crop category, which includes sugar beets, cotton, hops, and dry beans.

In terms of acreage, alfalfa has long been reclamation's major crop. The acreage devoted to all forage crops amounts to about half the total irrigated land. The use of over 70 percent of the land for feed grain and forage production testifies to the great importance these irrigated lands have to the livestock industry in the West. The feed production on project lands in 1959 was sufficient to produce the annual beef consumption of 17½ million persons.

Very little of the grain and forage produced on reclamation farms is ever offered for cash sale beyond the immediate project areas. Because of the use of these crops right on the irrigated farms or in adjacent rangeland areas, production from irrigated lands does not add to the crop surplus problem. Diversification of formerly dryfarmed lands via irrigation also enables farmers to tailor their production to crops that are in demand, such as the fruits, vegetables, seeds, sugar beets, et cetera.

Editor's note: The above summary results of 1959 crop production from Federal reclamation projects were furnished as the annual "crop report" was nearing completion. Printed copies of the report are available upon request from the offices of the Commissioner and the Regional Directors. #

L. to R.: Governor Stephen L. R. McNichols of Colorado; Governor Paul A. Fannin of Arizona; Robert Harvey, President of Merritt-Chapman and Scott Corporation; Governor George D. Clyde of Utah; Secretary of the Interior Fred A. Seaton; and L. F. Wylie, Project Construction Engineer for Glen Canyon Dam. *Photo by A. E. Turner, Region 4.*

FIRST CONCRETE PLACED AT GLEN CANYON

SECRETARY OF THE INTERIOR FRED A. SEATON, clad in white shirt sleeves and bronze hard hat, pulled the lanyard on June 17 to release the first 12 cubic yards of concrete to be placed in Glen Canyon Dam. The huge bucket of concrete was dropped on lowest bedrock at the downstream toe of the dam—710 feet below the crest elevation of 3,715 feet. Ended was 3½ years of preparatory work at Glen Canyon Dam, and begun was the 2½ year job of placing 5,000,000 cubic yards of concrete in the dam.

Following the tripping of the first bucket, the photographing of dignitaries, and the tossing of coins into the concrete by the many workers as a "good luck" omen, the assembled guests were immediately hoisted from the canyon by the "highline skip" and the placing of concrete continued in this lowest block of Glen Canyon Dam.

The first bucket ceremony began at 11 a.m. under the warm northern Arizona sun at the speaker's stand located on the canyon rim near the east end of the Glen Canyon Bridge. The colorful Navajo Tribal Band was on hand as well as many Navajo tribesmen and their families, and spectators and guests who came many miles by private car and by commercial and chartered aircraft.

After remarks by Governor Paul H. Fannin, Robert E. Harvey, President of the Merritt-Chapman and Scott Corporation, and Ival V. Goslin of the Upper Colorado River Commission, Secretary Seaton delivered the principal address. Then, while the invited guests walked down the wooden stairway to board the "highline skip" for the more than 800-foot drop into the "hole," the 3,000 spectators hurried to the bridge railing for their "crow's nest" view of the bucket tripping climax to the ceremony.

Master of Ceremonies L. F. "Lem" Wylie, Project Construction Engineer for the Glen Canyon Unit, and A. R. Bacon, Project Manager for MC&S, supervised the tripping of the first bucket in the canyon bottom. By radio-public address system communication, the people crowded to the bridge rail high above the damsite, heard clearly Secretary Seaton's remarks and the who-oo-sh of 24 tons of concrete dropped onto the exposed bedrock when Secretary Seaton pulled the lanyard. The bucket recoiled upward, the whistles on the rim sounded to punctuate the release of the first bucket, and, in a flash, the historic moment in the building of Glen Canyon Dam had come and gone.

But, for those who were there on this June 17, 1960—exactly 58 years after the Federal Reclamation Act of 1902 became law—the first bucket of concrete for Glen Canyon will be a never-to-be-forgotten moment. #

odd ball river

by K. FRITZ SCHUMACHER, Sierra Madre, Calif.

"ALL THE RIVERS RUN INTO THE SEA; YET THE SEA IS NOT FULL; UNTO THE PLACE FROM WHENCE THE RIVERS COME, THITHER THEY RETURN AGAIN." This is the Biblical statement of the hydrologic cycle from Ecclesiastes, chapter 1, verse 7. There is no conflict between science and religion here. All of our water supply follows this cycle, repeated indefinitely. It consists of precipitation in the form of rain or snow, runoff in streams, and finally, evaporation from the terminal sea. A detour is available by way of percolation into the ground. Some of this water eventually returns to the stream through springs. Some of it is trapped by growing plants and returns to the atmosphere by evaporation from plant surfaces, a process known as transpiration. By one way or another, the cycle is completed.

The Mojave is a nonconformist among rivers. From its birthplace on the roof of southern California in the San Bernardino Mountains to its dotage in the alkali flats of Soda Lake the Mojave's career is dedicated to every possible circumvention of the traffic code for law-abiding rivers.

All rivers, except a few odd balls like the Mojave, select a course in the general direction of the nearest ocean. From its source less than 100 miles from the Pacific coast the Mojave deliberately heads toward the Atlantic. It refuses to

Cliff on east side of Upper Narrows would be dam abutment.

Looking north or downstream through Lower Narrows 3 miles north of Victorville. ***(All photos courtesy the author.)***

mingle with the common herd of brother rivers in the Pacific Ocean. Instead, it selects its private terminal sea in the Great Basin of the Colorado Desert. Along its entire course it studiously avoids prompt fulfillment of the hydrologic cycle. It conserves the lifeblood of flowing water underground, well out of reach of surface evaporation.

Mother Nature has installed a number of traffic signals along the river's course. At each one our introvert stream is forced into brief surface flow conformity with ordinary rivers. One of these signals is the subsurface rock barrier just south of Victorville, known as Upper Narrows. A similar barrier 3 miles downstream, known as Lower Narrows, prevents our bashful stream from again ducking into the ground before this second signal is passed. The result is a perennial stream in a desert of negligible rainfall. It is a true oasis and, no doubt, encouraged the thriving community of Victorville to locate here.

An investigator for U.S. Department of Agriculture in a report on utilization of Mojave River describes the stream as unique. It possesses vast underground storage capacity. Its ground water is forced to the surface at frequent intervals, "so spaced that maximum benefits to man are derived."

Contrary to popular belief, underflow only rarely takes place in a natural cave or tunnel. It usually consists of slow percolation through beds of sand and gravel. Rate of percolation of about 50 feet per day was determined at Upper Narrows many years ago. Salt was introduced into ground water at the upstream end of a measured course. Electrical conductivity tests announced the arrival of the solution downstream. Rate of percolation varies widely and is expressed in feet per day or even feet per year. Velocity of surface flow, on the other hand, is most conveniently measured in feet per second.

There is reason to believe that Victorville fault, which forms the Upper Narrows barrier, impounded a natural lake several ice ages ago. Material eroded from San Bernardino Mountains filled this lake. Mojave River then had more water available as its eroding tool. Cajon Creek, which drains the same roof down the steeper south slope of the same uplifted mountain block, muscled in on Mojave's headwaters and hijacked some of its runoff.

The 50-foot layer of coarse sand over bedrock in Upper Narrows shows that the **V** notch carved into the rock barrier by the formerly more ro-

bust Mojave is of more than ample capacity to accommodate current flood runoff. Southern California Railway, predecessor to Santa Fe, boldly took advantage of the river-carved pass. On rare occasions old man Mojave resents this intrusion. The River tries to reassert its exclusive right-of-way and gives railway maintenance forces quite a tussle.

The same 50-foot sand layer over the bottom of Upper Narrows provides a safety factor against excessively high floodwater levels at Victorville. As the velocity of floodflow increases, some of this sand layer moves along as bedload. Up to 50 feet of additional depth is therefore available to pass floodwaters. A moderate rise of the water surface may be accompanied by a larger amount of bottom scour.

The Upper Narrows, which in Geologic times impounded a natural lake, is an excellent damsite. At the turn of the century test drilling surveys and plans were made by Columbia Colonization Co. for Victor Dam, 150 feet high, containing 70,000 cubic yards of masonry. The reservoir of 390,000 acre-foot capacity would back water to Hesperia and submerge $5\frac{1}{2}$ miles of railroad.

It takes much planning—political, financial, and technical—to launch such a project. It cannot happen overnight. In the meantime, settlers moved in and found out that pumping from shallow-depth wells took care of their needs very nicely. During many years of dam promotion efficient pumps were developed. Electric power became available at moderate cost. Interest in the proposed surface reservoir project subsided as the need for it was pumped away.

In most localities such a reservoir would increase the net safe yield.

On the Mojave the advantages of surface storage are less apparent. At present underground storage is ideal. It avoids evaporation losses from a reservoir exposed to dry desert air. It eliminates the need for an extensive canal network subject to transmission losses.

For the time being at least, the peculiarities of the odd ball Mojave River are permitting the desert of the same name to boom and bloom with minimum assistance by the works of man. # # #

Underslung steel arch bridge which carries California State Highway 18 across Santa Fe Railway and Mojave River.

Reclamation Commissioner FLOYD E. DOMINY, who during his first year in office, made almost a dozen speeches in nine Western States on the importance of conserving water, and at the same time cautioning of the impending water shortage, recommends the following editorial from the Arizona Farmer Ranchman as must reading:

HAIL THE IRRIGATOR:

Water is the one indispensable material used to produce crops in Arizona, and for many farmers the most expensive. University of Arizona research shows that the average cotton grower lays out $22.50 an acre and the same for insecticides; water costs him $13.51 in Salt River Valley and up to $37 in pump areas where the lift is 350 feet.

But there are several differences that place water in a different category. He can apply just as much fertilizer and insecticide as his judgment tells him is right; if he decides to apply neither he can still get something of a yield. If he applies no water he gets nothing.

There's a limit to his project water allotment, or to how much he can pump. No dealer in town is waiting on the phone, ready to deliver an extra supply of water if the grower decides that his cotton or his sorghum or his alfalfa needs another acre-inch.

Therefore, water should be treated with vast respect—a degree of respect that it receives on altogether too few farms.

Aside from the farm operator, the owner or lessee who does the planning and managing, the irrigator is the most important man on the place. Seldom, however, is he given the recognition or the pay that is his due.

Nobody else can have the operator's keen appreciation of how much his water is costing him in dollars right now, and how much more it will cost him if the water that is essential to maximum yields flows off down the waste ditch. He knows what the result will be if a corner of one field fails to get covered properly.

Often, though, the operator has so much to do that it is not possible for him to be his own irrigator. In that case he has to turn the job over to a hired man. That man should be carefully selected for intelligence, competence, and reliability. If he measures up in all these respects, he is an asset of great worth. He deserves better wages than a mere tractor driver or ditch cleaner, for to him is entrusted the most costly material used in crop production and the one that is absolutely indispensable. #

a story about the USBR and millions of fish

ON A WHOLESALE BASIS THEY CATCH 'EM AND HAUL 'EM

by ROBERT E. ALLING

Fisherman—how many fish did you catch in 1959? Twelve million? No? Well, you're not doing as well as the boys down at the Tracy Pumping Plant then because they did catch 12 million fish in 1959. Of course, they are fairly well equipped for the fish-catching business, and they have exclusive rights to a considerable flow of water, but it is still an interesting process.

The heart of the matter lies in the fact that the boss men of the Central Valley project do not want fish in the Delta Mendota Canal. Neither do the fish and game people, and if you are a fisherman, neither do you. The fish don't want to go there either, and the pumping plant people do not want them in their pumps. All concerned are in complete accord, so there are a group of men who operate what is known officially as the Tracy Fish Collecting Facility of the Central Valley project of California.

A fish is not the smartest critter in the world, but he does have some fairly well developed habits. One of these is that he will swim downstream every chance he gets. This is normally from the Delta area toward the Bay area, but not always. Sometimes the operators at the Tracy Pumping Plant flip switches and put their full 135,000 horsepower to work, and water from a large part of the Delta (at capacity, about 2 million gallons per minute) flows not toward the bay area but toward Fresno.

The average fish, however, has no slide rule. He can't figure this out, so he joins the crowd thinking all the while that he is going down to the sea. That is where he is going, too, but he is going to make the trip part way by truck, and there is some question as to whether this is the way he had his journey planned.

Fish become wards of the U.S. Bureau of Reclamation at the head of the Delta Mendota Intake Canal. This is the place where water leaves the natural waterways of the Delta and moves through a manmade canal about 2½ miles to the big pumps.

At this point, Mr. Average Fish first feels the influence of the USBR at the trash rack which keeps tules and trees, and boxes and broken up outhouses from reaching the pumping system. If the fish is big enough to swim against the current at this point, he will decide to forget the whole thing and go the other way. In this manner he stays where he belongs under his own steam.

Many fish, however, cannot swim against the

E. J. Neilsen, pumping plant maintenance superintendent (left), shows Rene Liegeois of Holt Brothers how louvers are raised for cleaning at the fish collecting facility. Everything at the plant is mechanized.

current. They flow right through the trash rack. Then they meet the primary louver system, and this 320-foot-long trinket works like this: A fish does not like turbulence. The louvers are set at such an angle as to make turbulence so the fish will sense these obstructions and avoid them. But at four points along the louver system, an environment that Mr. Fish does like is created and when he takes this route he is a guest of the Federal Government.

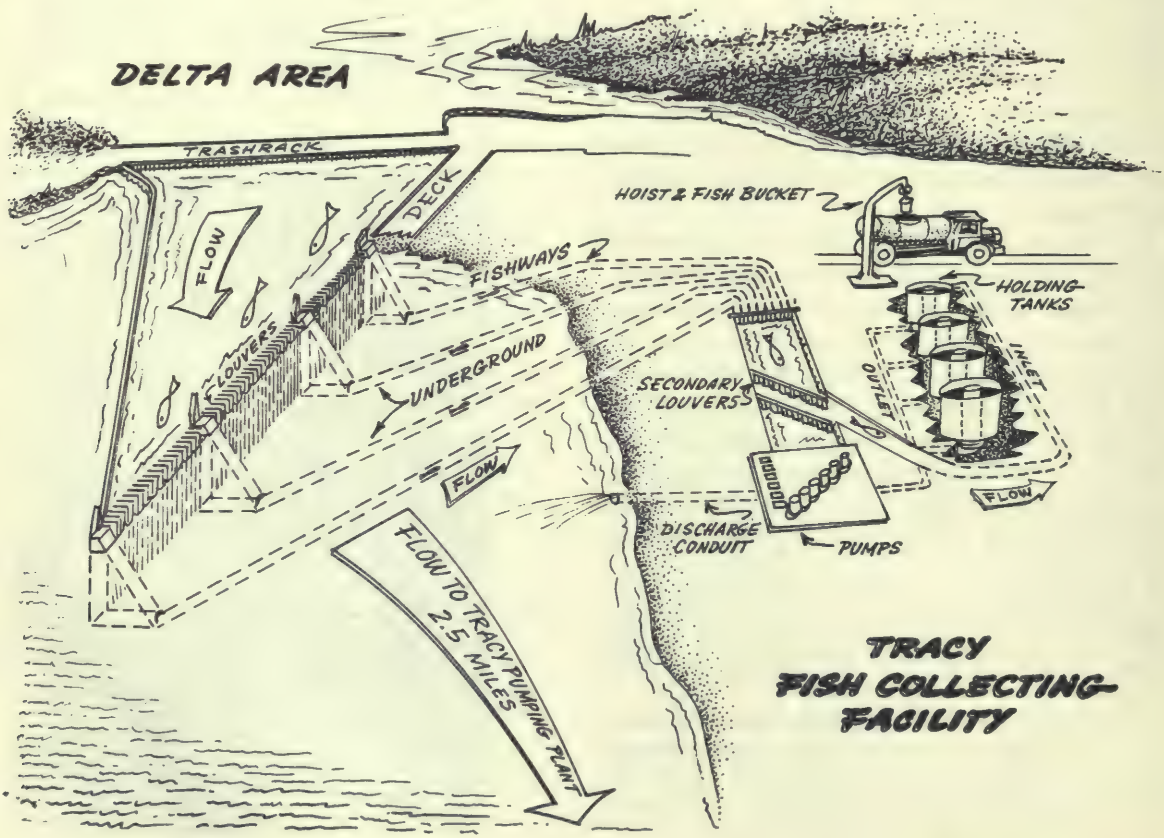
He is washed by the waterflow through a set of pipes to the secondary louver system and then to four big holding tanks. These tanks, each 20 feet in diameter and 16 feet deep, have cylindrical screens in the center through which incoming water passes while the fish collect at the outer edges of the tank. When a load is collected, a king-size bucket is lowered into the center of the tank, the screen is raised, water and fish flow into the bucket, and the whole works is hoisted over to a tank truck.

Water and fish are dumped into the tank truck from the bucket. From this place the fish are hauled to a point far enough downstream to escape the influence of the Tracy pumps (usually near Antioch), and they can continue their normal migration.

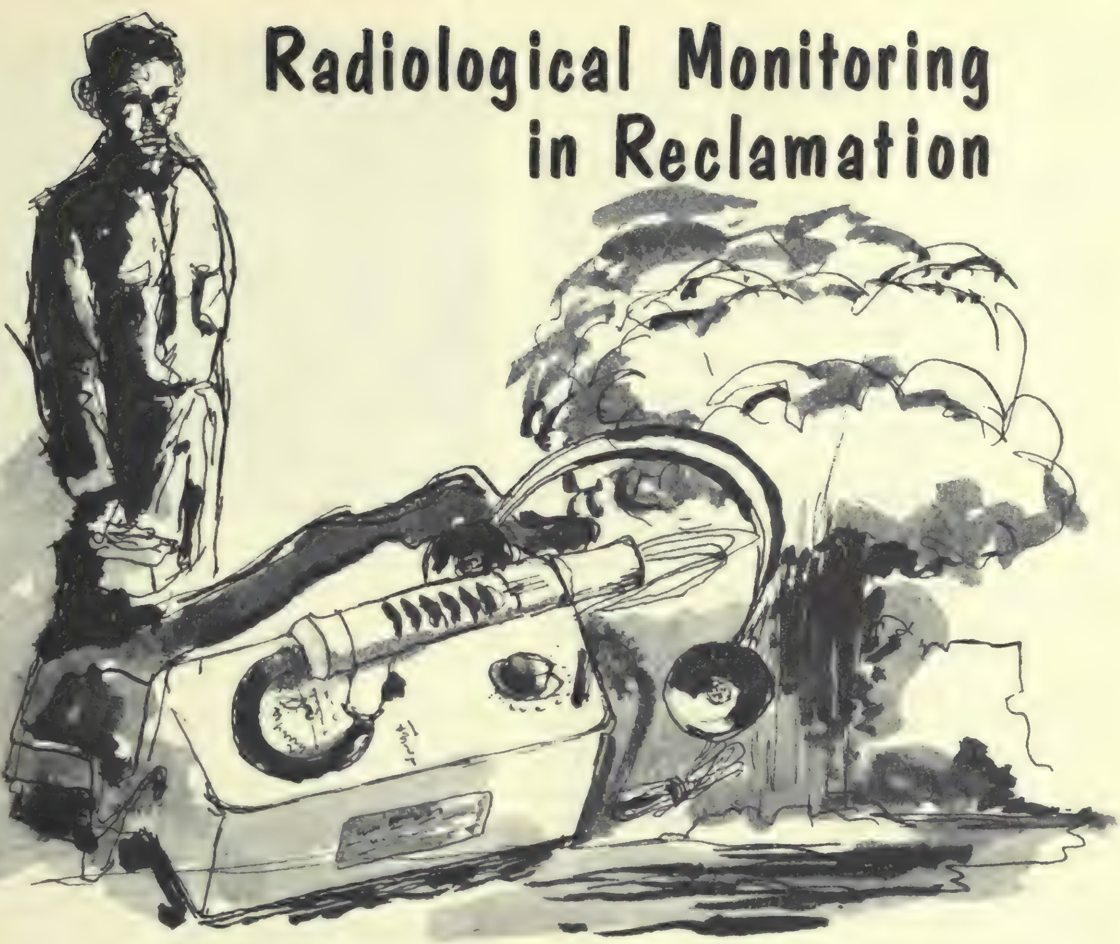
At first glance, it would seem that all this must be something considerably more than a minor annoyance to the fish, but the facts supported by countless tests are that it doesn't hurt them a bit. As a matter of fact, except for stewardesses, the truck has all of the comforts of a modern jetliner. There is a system to keep the water aerated and cooled to the exact requirements of ideal piscatorial transportation. They get a good ride.

All this was invented by a couple of extraordinarily smart people who accepted the challenge of solving the fish problem for the pumping plant when it was built several years ago. They are Russell Vinsonhaler of the Bureau of Reclamation and Dan Bates of the Federal Fish and Game Commission, and they have received commendations and special compensation for the design of the plant which has already saved the Government hundreds of thousands of dollars because of its efficiency.

(Continued on page 83)



Radiological Monitoring in Reclamation



The Bureau of Reclamation is carrying out a field program of training in radiological monitoring that is designed to detect radiation from nuclear fallout and thereby help in the protection and restoration of vital water and power service in the event of a nuclear explosion.

The Bureau of Reclamation's effort is part of a Department of the Interior program to provide continuity of operations during an emergency involving radioactive fallout. Such an emergency could be caused by use of atomic weapons in wartime or by a peacetime industrial accident as the use of nuclear energy grows. Many thousands of people are dependent upon Bureau of Reclamation operations for water and power and this mission would be more essential than ever in time of emergency.

by JAMES H. SALADIN, Tracy Operations Field Branch, Region 2 Radiological Defense Officer, Sacramento, Calif.

The size of the fallout area of a nuclear explosion is contingent upon many factors such as the size and type of the weapon, type of burst—whether surface, subsurface, or high-air—and meteorological conditions. A nuclear weapon detonated at or very near the surface of the earth produces the maximum amount of fallout because of the vast amounts of dust and debris that are sucked up in the mushroom cloud. A subsurface burst may produce varying degrees of fallout and while a high-air burst, with certain limitations, lessens the fallout problem, it creates a higher degree of blast and thermal damage. Fallout particles may be scattered by the winds over large areas. Precipitation will hasten the fallout and confine it to smaller areas, but the radiation levels will be higher because the fallout has not had time to undergo any appreciable amount of natural radioactive decay.

Plotting predicted fallout patterns is possible through the U.S. Weather Bureau's fallout forecast. However, accuracy is somewhat limited because winds are constantly changing, making accurate prediction difficult, although generally speaking, the upper-level winds across the continental United States blow in an easterly direction. But the only true indication of the degree of fallout intensities will be by the use of appropriate instruments in the field.

If one of our installations, such as a dam, powerplant, pumping plant, or control center, were in the impact zone of a multimegaton nuclear weapon let's face it—it's had it! But other facilities in the fallout zone 50 or 100 or more miles away could continue to function with proper protective measures. This continued operation is geared to two principal factors, shielding to reduce radiation exposure to personnel and effective measures to detect fallout.

To point up the effectiveness of shielding, we may assume that the unprotected acute exposure at a location would be 500 roentgens. This amount would be considered fatal to 50 percent of the people who receive it. Placing 12 inches of concrete or 18 inches of packed earth between us and the source of radiation would reduce the exposure to about 35 roentgens, thicker barriers would reduce the exposure still further. Many installations afford relatively good radiation protection as constructed but others need additional protection.

However, the heart of the protection program is the monitoring, to detect the amount of fallout and to undertake decontamination measures such as hosing down structures, access areas, walkways, etc. It is also essential to determine the amount of radiation in the water.

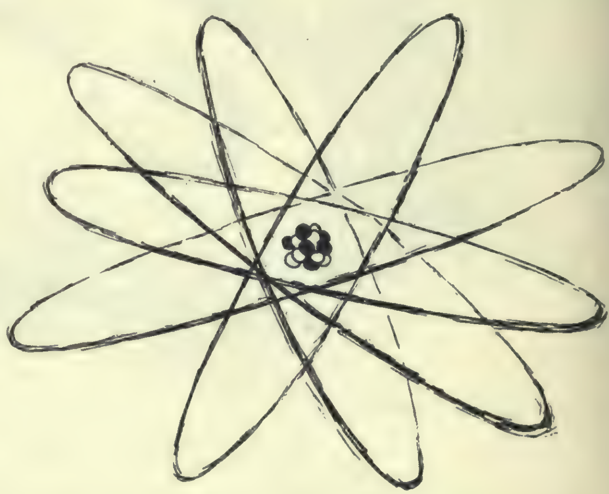
To carry out a monitoring program requires trained personnel, well skilled in operating Geiger counters, ion chamber type of survey instruments, dosimeters, and other related equipment. It is this training that is being carried on in the field.

Monitors must be trained to predict the behavior of radioactive fallout and to detect it. They must be taugh methods of decontamination and knowledge of maximum permissible exposures. The training is a constant process because regular practice and refresher courses are essential to keep alert after knowledge of radiological monitoring is acquired.

All essential types of survey instruments are furnished to the Bureau of Reclamation without cost by the Office of Civil and Defense Mobilization.

Radiological fallout is not going to end man's existence. The Chinese probably thought they held the key to man's annihilation when gunpowder was invented and Benjamin Franklin had some close brushes with death in his electrical experiments—examples of two forms of high energy that have ultimately improved man's lot through proper application. And nuclear energy is also being tamed and harnessed for man's advancement. But there is danger, danger that could bring disaster without safeguards.

Despite the dolorous portrayal of such novels and pictures as "On the Beach," there will always be survivors of the effect of nuclear explosions. Our purpose is to increase the percentage of survival following an attack by teaching people to understand the nature of radiation and how to protect themselves and to help in that process.



It is, of course, the hope of those trained in radiological monitoring, that their skills will never be required but if a nuclear explosion does occur, the importance of their services cannot be overemphasized. # # #

"GET ACQUAINTED" COPIES

If you have friends or associates who would be interested in the RECLAMATION ERA, please send their names and addresses to the Bureau of Reclamation, Washington 25, D.C. We shall be glad to send them copies of back issues.

"Ole" greets President Eisenhower at Grand Junction, Colo., during Ike's 1955 tour of Upper Colorado River.

"OLE" LARSON

(Continued from page 62)

fact and feasibility, fires it with enthusiasm, and turns it into reality." He is tenacious and stubborn enough to get his way. Were it not so, much of the water of the intermountain empire would be continuing wastefully on its way; the Upper Colorado River project would have remained a dream.

Ole had the knack of developing young engineers and getting from them their very best. He was kind and appreciative of their efforts and shared with them his successes. To his wife and family goes also Ole's praise and appreciation. He married his college sweetheart, Idona Blanchard, in 1919. They have two children and three grandchildren. Their son, Ernest Dixon Larson, is an engineer with Geneva Steel and their daughter, Joan, is married to Donald Ware, employed by an advertising agency in Salt Lake City.

Ole's future plans are for a busy retirement. He has associated himself with a consulting firm of domestic and international reputation. Although he packs travel credit cards good the world over, he proposes to make up to his family a few of the lonesome hours he deprived them of when demands on his time were more rigorous. In his retirement, we all wish him many years of satisfaction and happiness.

For his devoted leadership and dedication to the development of the intermountain empire, Reclamation pays tribute by naming Ernest O. "Ole" Larson as an illustrious member of the hall of fame. ###

SAN ANGELO

(Continued from page 68)

Always a conservationist at heart, he has also turned his attention to ranching and has been very successful through the proper clearing, planting, and irrigation of his land.

Mr. Bryant has always been a public-spirited individual and the following honors that have been conferred on him bear out this characteristic:

April 1952:
: Elected to the city commission of San Angelo for a 2-year term.

1952:
: Elected a director of the Gonzales Warm Springs Foundation for a 4-year term.

March 1953:
: Elected president of Texas Independent Oil Producers and Royalty Owners Association.

April 1953:
: Named to the National Petroleum Council by the Secretary of the Interior.

April 1954:
: Elected mayor of the city of San Angelo for a 2-year term.

January 1955:
: Appointed chairman of the water committee of the League of Texas Municipalities.

1956:
: Selected for San Angelo's citizen-of-the-year award.

August 1957:
: Named by Governor of Texas to statewide water planning committee.

January 1958:
: The San Angelo Lions Club presented Mr. Bryant with a plaque for his "outstanding contribution to water conservation in west Texas in 1957."

February 1959:
: Named outstanding conservation rancher of the year by the board of supervisors of the Eldorado Divide Soil Conservation District. # # #

"GET ACQUAINTED" COPIES

If you have friends or associates who would be interested in the Reclamation Era, please send their names and addresses to the Bureau of Reclamation, Washington 25, D.C. We shall be glad to send them copies of back issues.

Towline wheel system moving diagonally through a field without uncoupling.

SPRINKLER IRRIGATION

(Continued from page 60)

in three operations being performed with one sprinkler setting. The crop is irrigated, the soil fed, and foliar feeding with a layer plant safety factor are accomplished in a single operation.

Insecticides and fungicides are being applied through sprinkler systems with resulting success in insect and disease control. Excepting for discrepancies in underleaf coverage, a blanket sanitation of area occurs when the insecticides or fungicides are injected into the system near the end of an irrigation period.

Most certainly, sprinkler irrigation is becoming a major tool for scientific farming. The industry recognizes its role in conservation and welcomes the opportunity to work with those who work for conservation. # # #

Your Magazine

Are there particular types of articles which you would like to see in the ERA that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

WATERWEEDS

(Continued from page 70)

Application methods and dosage rates vary according to the physical size of the canal or reservoir to be treated, chemical and physical nature of the water, type of acquatic plants to be controlled, and the species of crop plants growing in fields which might possibly receive treated water. Normally only one point of introduction is required to treat a complete canal system. Due to this single injection technique "clean ditch" maintenance is possible at a minimum "per mile" cost.

Effective dosages are from 1 to 3 gallons per c.f.s. in canals, and from 0.5 to 2 gallons per acre-foot in reservoirs. Application time ranges from 45 minutes to 5 hours. The effective dosage rate as can be surmised, is a function of time multiplied by concentration. The location of the treated moving wave in a canal can be easily determined by a simple rapid analytical test.

The length of time of effectiveness varies depending upon time of application, but generally two or three applications per season should be sufficient to maintain adequate control of undesirable aquatic vegetation.

Reports show that "in less than a week after treatment the water carrying capacity of a 60-foot wide canal nearly doubled." The beneficial effect lasted for 8 weeks before retreatment was necessary.

Cost calculations show the process to be extremely economical. * * *

The herbicide currently is being marketed commercially in the Western United States and in Florida for use in flowing canals, ditches, and drains. ###

CANAL SAFETY BOOKLET

A new booklet, Canal Safety, has been published by the Bureau of Reclamation as an additional measure to protect the public, operating personnel, and animal life from the hazards of canals and other water-carrying structures.

Copies of the booklet may be obtained by writing to any Bureau of Reclamation field office. Regional offices are located in Boise, Idaho; Sacramento, Calif.; Boulder City, Nev.; Salt Lake City, Utah; Amarillo, Tex.; Billings, Mont. and Denver, Colo.

USBR AND FISH

(Continued from page 78)

A load numbering about 8,000 fish was collected and shipped off to the murky brown yonder while the photos accompanying this story were being taken. A real peakday will see about 250,000 fish collected and transported. The majority are catfish. Many are stripers. There are quite a few salmon, and during seasonal peaks nearly every tankful contains a surprise or two. Flounders are not uncommon, and on several occasions eels have been handled. Other normally oceangoing varieties get into the swim often enough to keep the plant's personnel wondering—What next?

All this is going on every day about 2½ miles northeast of the Tracy pumping plant which in turn is about 9 miles northwest of Tracy, and visitors are welcome. It makes an interesting excursion! ###

Reprinted through the courtesty of Holt's Gazette.—Ed.

NEW RECLAMATION BOOK PRESENTS DATA FOR USE IN DESIGN OF SMALL DAMS

A new technical book, *Design of Small Dams*, has been published by the Bureau of Reclamation as a guide to small water resource organizations, public agencies, and private engineers engaged in the design and the construction of small dams and retention reservoirs, the Department of the Interior announced recently.

In announcing the release of the new publication, Commissioner of Reclamation Floyd E. Dominy said that because of the Bureau's international reputation in the field of dam design there was a wide, continuing demand by the public for technical assistance by the Bureau's staff in the planning for and design of small dams. He said this demand was becoming more acute since an earlier Government publication, "Low Dams", published in 1938, had been out of print for several years during the current worldwide boom in water resource development.

Mr. Dominy explained that the public is entitled to the knowledge and experience amassed by the Bureau in a half century of dam building. "We believe," he said, "that making this information public is not only a substantial technical contribution to the water conservation program, but also that it will help bring about full upper-basin water development, with correlative benefits to large downstream storage reservoirs. Furthermore, by stimulating private and local initiative to construct the smaller dams, it will be contributing to the overall Federal policy of encouraging private capital and non-Federal agencies to assume a large and challenging public resource development task without turning to the Federal Government."

The book was prepared by Bureau personnel at the Commissioner's office in Denver, Colo., under the direction of Grant Bloodgood, Assistant Commissioner and Chief Engineer, and L. G. Puls, Chief Designing Engineer. More than 30 engineers and many technicians participated in the preparation of the book and in its critical review.

Copies of the new publication may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., or the Bureau of Reclamation, Denver Federal Center, Denver, Colo., attention 841. The price is $6.50, postpaid. #

COMMISSIONER DOMINY TO ADDRESS WESTERN RESOURCES CONFERENCE

Reclamation Commissioner Floyd E. Dominy is scheduled to address the second Annual Western Resources Conference to be held at the University of Colorado in Boulder, Colo., the latter part of this month. The exact dates of the conference are August 22 to 26.

Commissioner Dominy's topic will be "Research requirements for multiple-purpose water development." The theme of the conference will be "Water: Measuring and meeting future requirements," according to Chairman Morris E. Garnsey, professor of economics.

Others scheduled to participate in the conference include U.S. Senator Gale W. McGee of Wyoming, a member of the Select Committee on Natural Water Resources, who will be the keynote speaker on the subject, "Water requirements and water policy;" Theodore M. Schad, staff director for the committee; Warren H. Marple, executive secretary, Columbia Basin Interagency Committee, and Leonard B. Dworsky, committee member; Julius Margolis, School of Business Administration, University of California; Allen V. Kneese, Federal Reserve bank of Kansas City; Paul Julian and Leslie Fishman, University of Colorado; Vernon W. Ruttan, Purdue University; S. V. Ciriacy-Wantrup, University of California. #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award Date	Description of Work or Material	Contractor's Name and Address	Contract Amount
DS-5234	Colorado River Storage, Ariz.-Utah.	Apr. 12	Eight 155,500-hp, vertical-shaft, hydraulic turbines for Glen Canyon powerplant.	Baldwin-Lima-Hamilton Corp., Eddystone Division. Philadelphia, Pa.	$6,392,000
DS-5269	....do....	May 27	Four 96-inch ring-follower gates and platform assemblies for river outlets at Glen Canyon Dam.	Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala.	278,000
DS-5271	Boulder Canyon, Ariz.-Calif.-Nev.	May 26	One 105,000-kva power transformer for generator Unit N-8, Hoover powerplant.	S. A. des Ateliers de Secheron, Geneva, Switzerland.	193,677
DC-5274	San Angelo, Tex....	Apr. 1	Construction of Twin Buttes Dam. (Earthfill dam embankment 8 miles long with maximum height of 130 feet.)	H. B. Zachry Co., San Antonio, Tex....	11,836,428
DC-5275	Missouri River Basin, S. Dak.	June 13	Constructing foundations and furnishing and erecting steel towers for 57 miles of Oahe-Fort Thompson 230-kv transmission line.	Hoosier Engineering Co., Columbus, Ohio.	1,405,097
DC-5276	Columbia Basin, Wash....	Apr. 25	Construction of earthwork and structures for Hope Valley pumping plant and discharge line W78.8 and Frenchman Hills pumping plant and discharge lines W61 and W61C, West Canal laterals, Block 80, utilizing precast-concrete pipe for discharge lines, Schedules 1 and 2.	Lewis Hopkins Co., Pasco, Wash....	711,237
DC-5279	....do....	Apr. 12	Construction of earthwork, concrete lining, and structures for Block 80 laterals and wasteways, West Canal laterals.	....do....	1,213,629
DS-5280	Colorado River Storage, Colo.-N. Mex.	Apr. 8	1,500,000 pounds of 110-inch diameter outlet pipe for Navajo Dam, item 1.	Eton Metal Products Co., Salt Lake City, Utah.	214,000
DC-5284	Lower Rio Grande Rehabilitation, Tex.	Apr. 19	Clearing, and construction of earthwork, concrete lining, and structures for rehabilitation of C and G lateral systems.	Fitzgerald and Co., Donna, Tex....	503,080
DC-5285	Central Valley, Calif....	Apr. 21	Construction of earthwork, structures, and surfacing for relocation of Trinity County road, Swift Creek to Carrville.	Monte W. Brown, Redding, Calif....	663,594
DS-5286	Missouri River Basin, Nebr.	Apr. 20	Four 115-kv power circuit breakers for Chadron and Sidney substations.	General Electric Co., Denver, Colo....	116,200
DC-5290	Missouri River Basin, N. Dak.	May 16	Constructing foundations and furnishing and erecting steel towers for 84 miles of Jamestown-Fargo 230-kv transmission line No. 2.	Lindberg Construction Co., Jamestown, N. Dak.	1,329,905
DC-5293	Collbran, Colo....	May 4	Construction of earthwork and structures for Leon Creek and Park Creek diversion dams and Leon Park feeder canal, using monolithic concrete for the siphon barrels, schedule 1.	Cherf Brothers, Inc. and Sandkay Contractors, Inc., Ephrata, Wash.	445,806
DC-5294	Central Valley, Calif....	May 20	Construction of earthwork and structures for Spring Creek power conduit, tunnels Nos. 1 and 2, and Rock Creek siphon, utilizing steel-lined monolithic concrete for the Rock Creek siphon, schedule 1.	Winston Brothers Co.; Johnson, Drake, and Piper, Inc., and Green Construction Co., Minneapolis, Minn.	11,617,104
DC-5295	Missouri River Basin, S. Dak.	June 2	Construction of Fort Thompson substation, stage 01.	Electrical Constructors, Columbus, Ohio.	761,060
DC-5297	Middle Rio Grande, N. Mex.	June 22	Channelization of the Rio Grande, Belen Area, unit 2.	J. R. Cantrall Corp., El Monte, Calif.	360,016
DC-5300	Washita Basin, Okla....	June 23	Construction of earthwork, concrete and steel pipe, and structures for Foss Aqueduct; and Clinton, Bessie, and Cordell laterals, using symbol CPS pipe, Parts A and D.	Vinson Construction Co., Phoenix, Ariz.	3,826,245
DC-5302	Missouri River Basin, Nebr.	June 10	Construction of Red Willow Dam. (Earthfill dam embankment will be 3,150 feet long and 126 feet high.)	Bushman Construction Co., St. Joseph, Mo.	3,045,606
DC-5305	Gila, Ariz....	June 20	Construction of earthwork, concrete lining and structures for Wellton-Mohawk main conveyance channel, Sta. 2377+05 to 3304+22.59; and Snyder Ranch conveyance channel, Wellton-Mohawk drainage system.	Korshoj Construction Co., Blair, Nebr.	988,287
DC-5307	Klamath, Oreg.-Calif....	June 2	Construction of earthwork and structures for canal, lateral, and drains for Sump 2, Contract Unit 2.	John M. Keltch, Pasco, Wash....	151,285
DS-5308	Parker-Davis, Ariz....	June 7	Two 161-kv and six 69-kv power circuit breakers for Phoenix substation.	General Electric Co., Denver, Colo....	209,120
DC-5310	Middle Rio Grande, N. Mex.	June 10	Clearing, and construction of earthwork and structures for irrigation rehabilitation of Albuquerque Unit 4.	Mulvaney Construction Co., Albuquerque, N. Mex.	137,035
DC-5321	Weber Basin, Utah....	June 23	Construction of earthwork, pipe lines, and structures, including three equalizing reservoirs, for North Davis laterals, Unit 1, Davis Aqueduct lateral system.	Theo Wood Construction Co., Salt Lake City, Utah.	459,910
DS-5327	Missouri River Basin, S. Dak.	June 22	One 230-kv horn-gap switch and twenty-four 230-kv and five 69-kv disconnecting switches for Fort Thompson substation.	McGraw Edison Co., Line Material Industries Division, Milwaukee, Wis.	118,795
117C-588	Columbia Basin, Wash....	June 20	Moving and remodeling six 2-bedroom residences and six single-car garages; and constructing two service buildings for Blythe Watermaster headquarters and O&M housing at Sand Hollow pumping plant, Schedule 1.	Crescent Construction Co., Spokane, Wash.	145,905
617C-60	Riverton, Wyo....	May 17	Construction of earthwork and structures for open and closed drains in North Pavillion and North Portal Areas.	Hicks Construction Co., Riverton, Wyo.	127,819

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Major Construction and Materials for which Bids will be Requested through September 1960*

Project	Description of Work or Material
Central Utah, Utah	Clearing about 240 acres of trees and brush, 11 miles of fencing, and 3 farm sites from the Stanaker reservoir site, north of Vernal.
Central Valley, Calif.	Constructing the indoor-type Spring Creek powerplant consisting of the first stage construction of a 75- by 163-foot building, with reinforced concrete substructure and structural steel frame superstructure with walls of reinforced grouted masonry and metal siding, constructing valve structure, about 600 feet of 21-foot-diameter concrete-lined tailrace tunnel, and furnishing and installing penstocks. Northwest of Redding.
Do	Constructing the Stone Corral pipe distribution system consisting of about 25 miles of pipe varying in sizes from 6 to 30 inches for heads of from 25 to 125 feet and 7 small pumping plants of 5-cfs capacity and smaller and 4 moss-screen structures with traveling water screens. Near Visalia.
Do	Constructing the El Dorado pipe distribution system consisting of about 17.5 miles of 12- to 33-inch pipe in the main pipeline and about 15 miles of 6- to 12-inch pipe in laterals. Near Folsom.
Do	Earthwork and structures, including a structural steel girder bridge, and gravel surfacing about 5.5 miles of Carrville to Cedar Creek country road. About 50 miles northwest of Redding.
Do	Furnishing and installing two 83,333-kva, 90 percent power factor, 225-rpm, 13,800-volt, 60-cycle, vertical-shaft, a-c generators for Spring Creek powerplant.
Do	Furnishing and installing two 55,555-kva, 90 percent power factor, 200-rpm, 13,800-volt, 60-cycle, vertical-shaft, a-c generators for Trinity powerplant.
Do	Furnishing and installing two 74,444-kva, 90 percent power factor, 225-rpm, 13,800-volt, 60-cycle, vertical-shaft, a-c generators for Clear Creek powerplant.
Do	Three 300-ton traveling bridge cranes, one each for Clear Creek, Spring Creek and Trinity powerplants, and four 150-ton trolleys. Total estimated weight: 960,000 pounds.
Chief Joseph Dam, Wash.	Constructing the outdoor-type East Unit Main pumping plant on a pier in the Columbia River, with a bridge to the shore, and an indoor-type flat-slab booster plant. Work will also include constructing a 2-million-gallon reservoir and discharge lines, and furnishing and installing fish screens. East Unit Main pumping plant, near Wenatchee.
Colorado River Storage, Ariz.	Two frames and sets of anchor bolts for 10.33- by 10.33-foot bulkhead gate at Glen Canyon dam. Estimated weight: 150,000 pounds.
Colorado River Storage, Colo.	Earthwork and structures, including 2 structural steel bridges, for about 12 miles of narrow-gage railroad, and earthwork and structures, including a structural steel bridge, and gravel surfacing for about 8 miles of county road. D&RGWRR (around Navajo reservoir), near Arboles.
Colorado River Storage, N. Mex.	One 6- by 13-foot fixed-wheel gate for Navajo dam. Estimated weight: 84,500 pounds.
Colorado River Storage, Utah.	Two 66-inch ring-follower gates for Flaming Gorge dam. Total estimated weight: 105,000 pounds.
Fort Peck, Mont	Additions to Shelby substation (Glacier Co. REA) will consist of constructing concrete foundations, furnishing and erecting steel structures and modifying an existing structure, and installing a 115-kv circuit breaker and associated switches and electrical equipment, major items of which will be Government-furnished.
Lower Rio Grande, Tex.	Earthwork and structures for rehabilitating about 15.6 miles of "F" lateral which will consist of reshaping the prism and banks and constructing unreinforced concrete lining in the new section. Near Mercedes.
Minidoka, Idaho	Additions to the Burley substation will consist of grading and fencing the substation area, constructing concrete foundations, furnishing and erecting steel structures, installing two 5,000-kva, 34.4-7.2/12.47-kv power transformers and one 14.4-kv recloser, and associated electrical equipment, major items of which will be Government-furnished.
MRB, Mont	Earthwork and structures, including a structural steel bridge, and laying track for about 14 miles of Union Pacific Railroad around the reservoir to be created by Clark Canyon dam. Near Dillon.
MRB, Nebr	Constructing about 12 miles of 28-foot bottom width canal, 5 miles of which will be earth-lined, and appurtenant structures including eight 11-foot-diameter siphons. Sherman Feeder canal (first section), near Arcadia.
Do	Constructing about 7 miles of 28-foot bottom width canal and appurtenant structures, including about 2,000 linear feet of 11.5-foot circular tunnel. Sherman Feeder canal (second section), near Arcadia.
MRB, N. Dak	Furnishing and stringing 954,000 circular mil ACSR conductors and 0.5-inch steel overhead ground wires for the 99-mile, 230-kv, single-circuit, steel tower Bismarck-Jamestown No. 2 transmission line.
Do	Stage 06 additions to the Fargo substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing one 230-kv circuit breaker and associated electrical equipment, major items of which will be Government-furnished.
Do	Stage 02 additions to the Rugby substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and installing one 115-kv circuit breaker and associated electrical equipment, major items of which will be Government-furnished.
MRB, S. Dak	Surveying, furnishing and constructing a complete microwave radio communications system with about 12 telephone channels, 22 telemeter channels, and 11 transmission line relaying channels. Terminals at Watertown, Huron, and Fort Thompson substations, and Oahe and Fort Randall powerplants, and repeater stations as required. Contractor to maintain system for one year after construction is completed.
Rogue River Basin, Oreg.	Earthwork and structures for the rehabilitation of about 18 miles of Talent lateral.
Smith Fork, Colo	Constructing the 984,000-cubic-yard Crawford earthfill dam, 160 feet high and 575 feet long, and appurtenant structures consisting of a tunnel outlet works and an open chute spillway. About 13 miles southeast of Hotchkiss.
Washita Basin, Okla	Constructing 3 indoor-type pumping plants with 3 vertical pumping units of 23.25 cfs, 3 horizontal pumping units of 9 cfs, and 3 horizontal pumping units of 6 cfs total capacity. Each pumping plant is to have a reinforced concrete substructure and a concrete masonry superstructure with timber roof framing, sheathing, and 4-ply built-up roofing. Foss aqueduct, near Clayton.

*Subject to change.

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REGION 2: Hugh P. Dugan, Regional Director, Box 2511, Fulton and Marconi Avenues, Sacramento 11, Calif.
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The Reclamation Era

NOVEMBER 1960

Official Publication of the Bureau of Reclamation

The Reclamation Era

NOVEMBER 1960 **VOLUME 46, NO. 4**

In this issue . . .

J. J. McCARTHY, Editor

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President Theodore Roosevelt stands proudly on the flag-draped rostrum at Theodore Roosevelt Dam following his dedicatory Speech March 18, 1911. All photos courtesy of the author.

Theodore Roosevelt Dam's Golden Year

GOLDEN YEAR of Theodore Roosevelt Dam started at 5:48 p.m. on March 18, 1960 and will end in March 1961. It was at that exact minute in 1911 that Teddy Roosevelt pressed the button that started water gushing through the turbines of Theodore Roosevelt Dam.

Dedication of the dam marked the beginning of the Salt River Valley's "Golden Age," which Webster defines as "a period of great prosperity and progress."

The huge reservoir, along with subsequent storage facilities on the Salt and Verde Rivers, assured the Valley of an adequate water supply, making possible the existence of today's mushrooming populace.

Theodore Roosevelt Dam, keystone of the Nation's first multiple-purpose reclamation project organized under the National Reclamation Act of 1902, signified the end of a long, difficult struggle in the Valley to cast off the bonds of fear instilled by the ever-present shadow of drought or flood.

Saturday, March 18, 1911, was a holiday in the Valley. The entire countryside buzzed with excitement as the day dawned clear, bright and warm—a perfect day for an event significant in Arizona's history.

A caravan of some 200 automobiles made the trip from Phoenix up the Apache Trail to the damsite with the former President of the United States riding in the lead vehicle. Fifteen hundred people—farmers, businessmen and Indians, a majority of them from the Valley, gathered for the dedication.

After his speech to the assembled throng, Mr. Roosevelt pressed the button, sounding a buzzer in the powerhouse, signaling James Lane, a Water Users' Association employee, that the time was at hand. Lane twisted a valve and sent water churning through the turbines.

Construction of Theodore Roosevelt Dam below the confluence of Tonto Creek and the Salt River was a herculean task, but the people tackled it with force and vigor, giving labor, money, and endorsement with the knowledge that the project would insure the Valley's prosperity and future.

Before actual building of the dam could begin it was necessary to complete considerable preliminary work, such as surveys, stringing of telephone lines, and building a road. Apache Trail, stretching from Mesa to the dam, was virtually

By JAMES V. STONE, Salt River Project, Phoenix, Ariz.

Theodore Roosevelt arriving at dam for dedicatory ceremonies.

carved out of the rocky mountainsides and is still one of the most picturesque roads in the West.

The first stone for Roosevelt Dam, quarried from the surrounding mountains, was 10 inches thick, 3 feet wide and 4 feet long. It was laid as the cornerstone on September 20, 1906. Work on the structure was continuous, day and night, until a height of 150 feet was reached.

The dam, although complete in most details by the end of 1910, still had about 150 feet of parapet wall to be finished. The last stone was laid on this wall on February 5, 1911, and the dedication was set for 42 days later.

Shortly before the turn of the century the Valley, which for several years had enjoyed some degree of success, was sidetracked on its way to prosperity as drought spread across the cultivated acres, grimly destroying years of hard work.

Beginning in 1897 one of the worst droughts in history hit the Valley and lingered on for 3 years. Slowly but surely the Valley began to wither and the population dwindled. While the Spanish-American War raged, the Salt River Valley pioneers seemed about to follow the path of defeat that befell the Hohokam civilization centuries before.

Like all the American frontiersmen, the Valley farmers could be pushed just so far—even by a killing drought. The drought problem was actually a problem of water storage. A large reservoir was needed to store the water and a dam was needed to regulate its distribution to the Valley.

The idea was not new, but none had considered it with little more than passing interest until the very basis of the Valley's economy was in peril.

After considerable discussion farmers in the Valley organized the Salt River Valley Water Users' Association, a consolidation of several canal companies, and then came enactment of the National Reclamation Act of 1902, assuring Government aid in the dam project.

In 1955, Project President Victor I. Corbell made the last payment on the original construction cost of the Project's first major dam. In presenting the check for $159,500.10 at a convention of the National Reclamation Association, President Corbell said, "This is the final payment to the United States on the original $10,166,100 loan to the Salt River Valley Water Users' Association, and it is proof positive that reclamation pays its own way."

"Great things will happen in this Valley due to this great project."

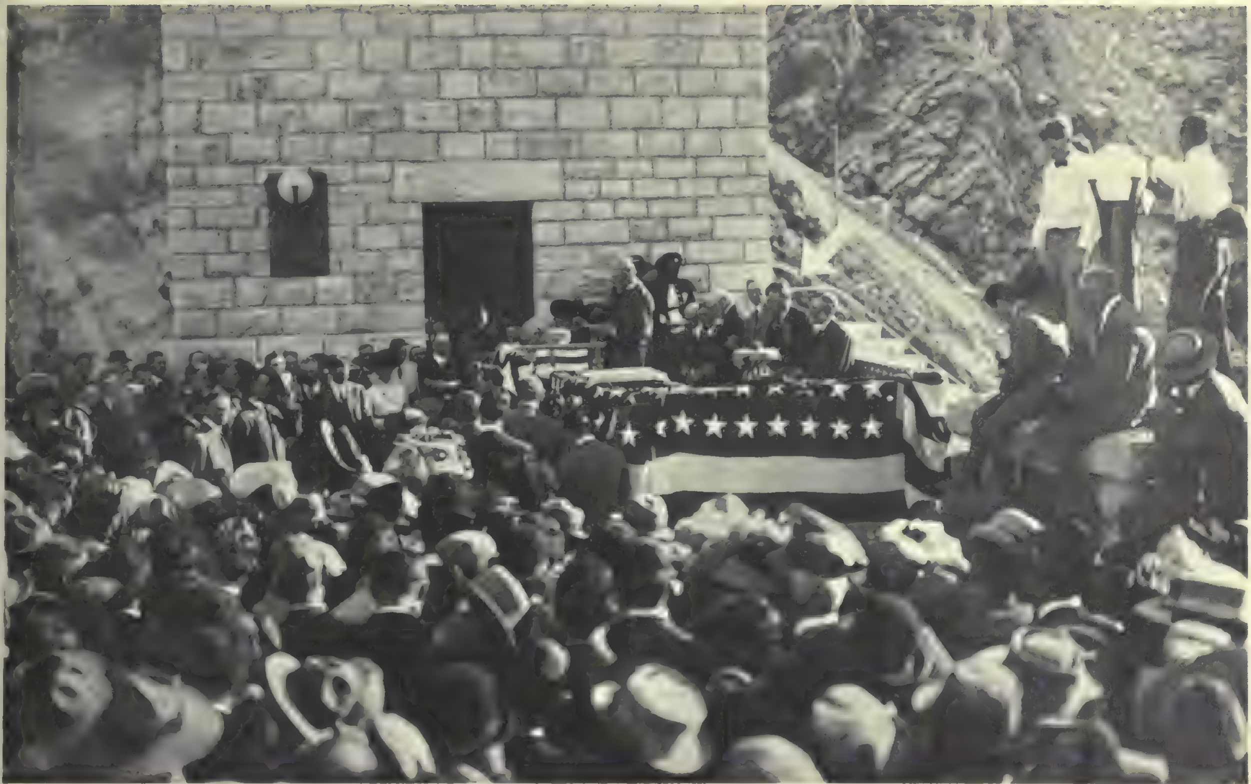
So said a former President of the United States as he shook hands with a future President of the Salt River Project at the dedication of Theodore Roosevelt Dam on March 18, 1911.

The former chief executive of the USA was Theodore Roosevelt, for whom the massive bulwark on the Salt River was named, but little did Vic Corbell, then a lad of 16, dream that he would

Large crowd gathering on roadway on top of dam for dedication ceremonies.

one day head up the Project that insured future prosperity for the Valley.

Vic was one of the few youngsters on hand for the rousing celebration amid the towering cliffs lining the Salt River—a celebration that marked the liberation of the Valley of the Sun from the



John P. Orme, President of the Salt River Water Users Association, addressing the assembly. The white arrow indicates former President Theodore Roosevelt.

ever-threatening spectre of drought.

For days and even weeks before the dedication day the Valley was tense with excitement. In the words of Mr. Corbell, "the air was almost alive, tension extending from the older folks right down to the kids. Everyone wanted to be there. Completion of the dam was an important thing to the Southwest, and everyone wanted to see this great man, known as the Father of Reclamation, who had been such a help to the people of our Valley."

A trip to Roosevelt a half a century ago was a far cry from the 2-hour jaunt it is today over the twisty Apache Trail. In Vic's case it required considerable long-range planning, including the training of a pair of saddle ponies to pull double.

Vic had made two trips to the dam with his father, Charles A. Corbell, during construction and was familiar with the route. The Corbells visited the site shortly after the foundation was laid and another time when the structure was damaged by flood waters.

Many days before the dedication, Vic and two cronies, Albert Skanks and Charles Parry, son of the Tempe village blacksmith, started laying plans for the trip. First they borrowed a light spring wagon from Charlie Mullen, of Tempe, and then broke Vic's saddle pony and Parry's mount to work with a double hitch.

The dedication rites were scheduled for Saturday, March 18, and the boys pulled out of Tempe about 10 a.m. on Wednesday, the 15th. Their toughest problem was loading the wagon with bed rolls, sufficient food for the boys, hay and grain for the horses, and the three boys. Ward Bond himself of TV's "Wagontrain" couldn't have done a better job of packing.

For protection they had a shotgun and Vic's dog. They camped out the first night near Government Wells stage station. Parry had done considerable trapping in the Valley and was hoping to trap a mountain lion during the trip. So before bedding down he set a trap about 200 yards from camp.

Early the next morning the youths were awakened by animal screams in the brush and they rushed to the trap only to find Vic's dog caught in the snare. The dog wasn't hurt too badly but he did get to ride the balance of the trip.

The safari up the Salt spent Thursday night at the Fish Creek stage stop, pulling into Roosevelt

on Friday afternoon. Camping space was at a premium, not because of the large crowd but due to the rocky terrain, and the boys spent the night in a long arroyo. "If it had rained we'd have been washed out," said Vic.

One of the worst hazards on the trip up the Trail was stalled automobiles. "Some we helped push out of the way and others we were able to get started again. Then we were in trouble. Every time one of those engines cut loose, it scared the horses and we had a near-runaway on our hands."

By the time the fellows arrived at Roosevelt they were tired of their own cooking so they ate with other folks camped nearby. Only two of them were able to attend the dedication banquet. Parry didn't have any money and the other two couldn't scrape up enough between them to pay his way.

The return trip was made in shorter time, since the load was much lighter. The group left the damsite early Sunday, spent the night at Government Wells, and arrived in Tempe about noon Monday.

"Teddy Roosevelt was a very impressive man," said the Project president. "I was standing close to him during the dedication and after the ceremony he shook hands with everyone, including me, and it was pretty much of a thrill.

"His prophesy that 'great things' would happen in our Valley has certainly come true as evidenced by the vast development now taking place, a development in all sections of the Valley that has exceeded almost all expectations." # # #

Close up view of native stone facing for upstream and downstream sides of dam.

Native stone used for facing was quarried from neighboring mountain. All photographs courtesy of the author.

EDITOR'S NOTE: *A bronze plaque formally naming the Salt River Project's largest storage facility* THEODORE ROOSEVELT DAM *will be unveiled during elaborate ceremonies planned for March 18, 1961. The 1961 rites will be held on the 50th anniversary of the dedication of the dam by the 26th President of the United States, for whom the dam was named. The plaque to be unveiled March 18, 1961, will be in addition to the original plaque now at the damsite. Mr. Stone tells a dramatic story of the dedication 50 years ago of this first great Reclamation multipurpose dam, and the hardships in the Salt River Valley that preceded its construction.*

HAROLD G. ARTHUR NEW ASSISTANT DIRECTOR AT BILLINGS

Harold G. Arthur, of Denver, Colo., was recently appointed Assistant Regional Director in the Bureau of Reclamation Region 6 office at Billings, Mont.

Arthur, appointed by Reclamation Commissioner Floyd E. Dominy, succeeds L. W. Bartsch who recently accepted employment with the World Bank. The Region includes the upper tier of Missouri River Basin States, principally eastern Montana, northern Wyoming, and North and South Dakota, all under the jurisdiction of Regional Director Bruce Johnson.

REHABILITATION AT RIO GRANDE

During the years of World War II and shortly thereafter, economic conditions on the 160,000-acre Rio Grande Project in New Mexico and Texas were almost all that could be expected. Crop yields were good; prices received for crops were good; and the water supply in Elephant Butte and Caballo Reservoirs was excellent. How could there be any problems under such conditions?

Problems there were; during the war period, heavy equipment needed as replacement for units of considerable age and expensive upkeep could not be obtained. Skilled labor was all but impossible of recruitment. The result, a slowdown of all important maintenance on the drainage and irrigation system. True, at the end of the war both irrigation districts of the Project—the Elephant Butte Irrigation District in New Mexico, and the El Paso County Water Improvement District No. 1 in Texas—began providing additional funds to step up the maintenance program.

Unfortunately, another period more critical to the Project than the war years began in 1951 and lasted through 1957. A severe water shortage, due to low inflow of the Rio Grande into Elephant

by W. F. RESCH, Project Manager, Rio Grande Project, El Paso, Tex.

DRAIN BEFORE CLEANING

BEFORE. No question about need for rebuilding.

AFTER. Rehabilitation completed.

Butte Reservoir, was being experienced. Never in the recorded history of the Rio Grande at San Marcial, N. Mex. (head of Elephant Butte Reservoir), was there a low inflow period comparable to the inflow for the years 1950–56, 7 long years of water shortage, with only 1 year of the 7 approaching average annual inflow.

Annual farm water requirement of 3 feet per acre could not be had. In fact, the shortage was so severe that in 1954 only 6 inches of storage water were available, in 1955 only 5 inches, and in 1956 only $4\frac{7}{10}$ inches. The remaining years also experienced allotment to Project farms below the required average 3 feet.

To meet the water shortage emergency, the water users, individually, drilled and financed about 1,750 irrigation wells. In addition to financing the drilling and equipping the wells with pumps, the water users, individually, have paid the pumping costs.

This emergency need for supplemental water, with attendant high development and operation costs, compounded the delay of maintenance that first occurred during the war years as it was now necessary to reduce operation and maintenance costs resulting again in a maintenance slowdown upon the irrigation and drainage system.

During the water shortage, with the consequent lowering of the ground water table as a result of the pumping to obtain supplemental water, the 450 miles of open, gravity drains dried up, and within a few years many miles of the drains were infested with a thick growth of vegetation, willows, cottonwood, salt cedar, and other brushy vegetation.

Beginning in 1957 there was some improvement in the storage water supply. The ground water table began to rise, the drains began flowing, and nearly normal demands on the irrigation system again were possible. The need for a stepped up maintenance program was evident, and consideration to undertake the completion of the war-deferred maintenance and the slowdown in maintenance during the critical water years was receiving serious attention. The need involved the repair or replacement of canal, lateral, and drain structures, a great many being 45 years old, and of timber, or combination timber and concrete construction. In addition, and very important, the cleaning of the drains was mandatory in order to remove the accumulation of weed and brush that grew in the drains, during the years they

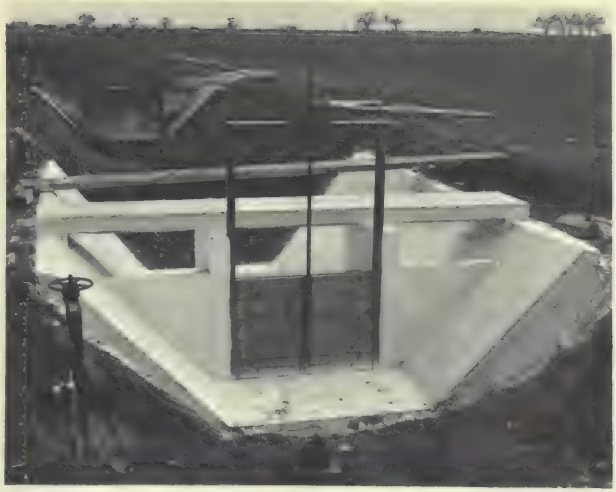
were dry, as well as to restore drain grades for the control of ground water elevation.

To accomplish the required work, nominal increase in the annual operation and maintenance rates was insufficient; and to impose a large increase in the annual operation and maintenance rates was undesirable, as the water users were still required to carry the financing of the irrigation wells, and were now operating under an acreage control program which caused the diversion or idleness of some 16,000 to 17,000 acres of land formerly in cultivation. In addition, the annual O&M rate of necessity was reflecting the increase in costs indexes of materials, equipment, and personnel.

The El Paso County Water Improvement District No. 1 (Texas Unit of the Project) requested the Bureau to prepare a program to accomplish the needed work under the Rehabilitation and Betterment Act of 1949. A program, based on a 5-year accomplishment period, was approved by the electorate of the District in 1959; and a contract providing for repayment of the $2,300,000 cost of the program was negotiated and executed in behalf of the United States and the District on May 15, 1959.

Essentially, the work to be performed in the Texas District is cleaning of the drains, repair or replacement of worn out checks, culverts, bridges, repair or installing of concrete lining, rewiring of ditchrider houses, and other related types of betterment for the irrigation and distribution system.

An important consideration was the manner in which the work should be accomplished, that is, whether by contract or by expansion of the existing maintenance forces. The decision was to expand the maintenance forces, as contract procedure would be faced with a difficult problem in programing due to the necessity of delivery of water to farms below El Paso for 11 months of the year. This type of irrigation service is particularly difficult during the fall-winter months, due to irregularity and uncertainty of orders for water service with the result that contract procedure would be required to expect standby time for work crews and equipment during unanticipated water delivery to farms scattered throughout the El Paso Valley. However, contract procedure is in the picture. For example, all concrete is contracted for as ready mix with the points of delivery being as much as 40 miles from the contractor's plant. Replacement of timber bridges contemplates the use of concrete pre-



AN EXAMPLE OF REHABILITATION

stressed girders and beams which will be purchased under contract. Other items such as canal fencing, rewiring, and other features will also be by contract.

The experience during the first year of the program justifies the decision to accomplish the work by expanding the maintenance forces. When unexpected irrigation service must be met, in any locality, the crews can be assigned to maintenance. Thus, no performance time is lost as a result of standby. In addition, the maintenance forces are well acquainted with the water users and can readily and satisfactorily resolve time requirements for both the program and the irrigation service.

The program is now beginning its second year and is beyond any doubt proceeding in a highly satisfactory manner. One important factor of the program is that the contract with the District provides for approval by the Board of Directors or its authorized manager of the annual program before any work commences. This working together on the development of the annual program has resulted in mutual understanding of the problems involved, the magnitude of the work that is necessary, and the procedures and programing required so that the entire program can proceed in an expeditious and economical manner. ###

"AGGRESSIVE MAINTENANCE"

"Aggressive maintenance" is the key to an irrigation system's long life, says Manager William Creason of Minidoka Project in Idaho. In since 1907, he expects the project to last another 50 years.

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MINT CAPITAL OF THE WORLD

Lying east of the Cascade Mountains in the south-central part of the State of Washington, the Yakima Valley has emerged triumphantly as the "Mint Capital of the World." The name "Yakima" is Indian in its origin, being derived from the great Indian tribe which inhabited the "Big Valley." This same name was given to the once turbulent river which now, regulated by numerous reservoirs and diversion dams, flows serenely through the valley fed with its life-giving water from majestic snow capped mountains on either side.

Since the authorization of the Federal Reclamation Project in the Yakima Valley in 1905, approximately one-half million acres of sagebrush and desert land have been transformed into one of the most productive, irrigated, farming areas in the Nation and has made possible this area's fantastic mint production.

Last year, Washington State produced 41 percent of the Nation's peppermint oil and 65 percent of the spearmint oil. Of the 13,300 acres of peppermint raised in Washington, approximately 11,300 acres were produced in the Yakima Valley. This same area produced approximately 4,000 acres of Washington's total spearmint production of 4,600 acres. This year Washington will harvest 13,300 acres of peppermint and 9,500 acres of spearmint. It is not difficult to see how the Yakima Valley has earned the title of the "Mint Capital of the World."

Until a few years ago, the Midwest was the mint oil center of the world, but acreage has declined there, largely because of a losing battle with the dreaded verticillium wilt. At the same time, there has been a sharp increase in the acreage in the Northwest. The secret of the Yakima Valley's phenomenal rise to its present position in mint production is the exceedingly high yield. The source of this fabulous yield is rich, fertile soil, plenty of sunshine and warmth, controlled irrigation, and freedom from disease.

Although the 1959 per-acre yield of peppermint oil in the Yakima Valley was 75 pounds, as com-

by L. R. SWARNER, Chief, Land Resources and Development Branch, Division of Irrigation, Boise, Idaho

pared with the record yield of 94 pounds per acre in 1958, the yield is still twice the Midwest's average of approximately 34 pounds per acre. Likewise with spearmint, the 1959 per-acre yield of 95 pounds is over twice the 38-pound average in Indiana, and the 30-pound average in Michigan, the only other major spearmint producing States. The $4\frac{1}{4}$-million dollar mint crop value in Washington in 1959 provides ample evidence that the mint industry has reached the proportion of big business.

Although earlier it was considered essential that peppermint be produced on a muck soil, it is being produced on a mineral soil which is slightly alkaline in reaction in the Yakima Valley. When an adequate quantity of water is provided to mint grown on mineral soils through controlled irrigation, the yields are superior to those obtained on muck soils found in the Midwest and in western Oregon and Washington even though the muck soils provide a continuous and adequate supply of moisture.

Mint is produced from rootstocks planted in rows in the spring while still dormant. Row planting allows for cultivation and irrigation. One of the unique features of mint raising is the use of geese to control the grass in the mint field. The geese are herded from one field to another and are generally removed from the fields when the mint is 12 to 15 inches high. Although the geese eat the grasses, they do not eat the broad leaf plants. Careful weeding and cultivation are necessary to keep weeds from the mint as they may seriously affect the odor and flavor of the oil which is distilled from the hay at harvest.

Harvest generally starts in the Yakima Valley about the middle of July. Any spearmint harvested by August 1 is usually harvested the second time during the same season, depending somewhat upon the fall weather. Peppermint is harvested only once during the season and harvest usually starts the first of September. The mint is cut and left to wilt in a windrow for 24 hours. A pickup chopper picks the mint forage up from the wind-

Broadview Farm's tractors, trucks, and other equipment (*Photo courtesy of Broadview Farms*)

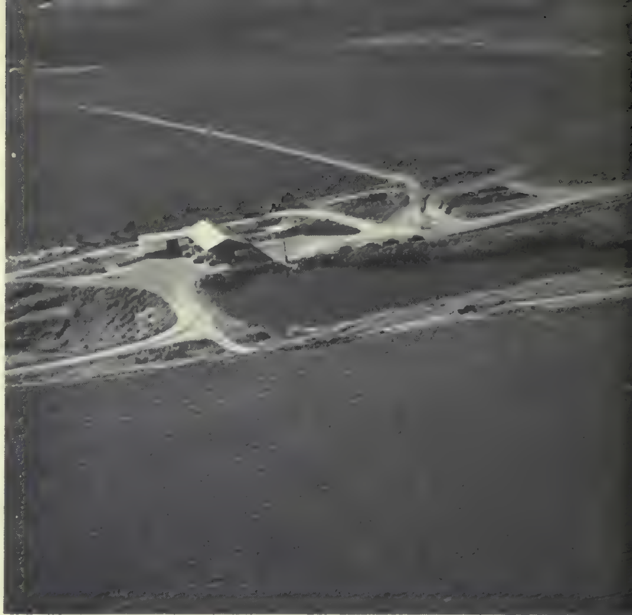
row and chops it into a tank truck which has been specially built and is equipped with steam pipes. Two men tramp and keep the chopped forage level in the tank truck. After the truck is filled, it is driven from the field into a stall at the mint distillery where the tank, which remains on the truck, is connected to the steam lines from an oil-fired boiler. After a lid is bolted in place on the tank, live steam is turned into the tank of chopped mint forage.

Steam is left on the spearmint for approximately 1 hour and 15 minutes and for approximately 1 hour and 30 minutes for peppermint. During this process the oil, which is on the outside of the leaf, is volatized and carried to a condenser where it is cooled and placed in a receiving container. The oil, being lighter than water, rises to the surface and is decanted into a 50-gallon drum for shipping to dealers of mint and other essential oils.

One of the largest mint operations in the world is the Broadview Farming Company's located in the Yakima Valley near Sunnyside and managed by Henry Callison, pioneer in the Yakima Valley's mint industry. This season the company will raise 1,600 acres of spearmint and 200 acres of peppermint. Their still, which is the largest in the world, can handle 75 truckloads of mint forage in 1 day. In addition to taking care of their own mint, a considerable amount of custom work is done. During the past several years, they have processed between four and five thousand acres of mint each season.

Although the price of peppermint oil has declined from over $6 per pound in the mid-40's to around $3 per pound in 1959, the high yield obtained in the Yakima Valley still makes mint growing a profitable industry. Likewise the price of spearmint oil has declined from $6 per pound in 1952 to $3.50 in 1959.

Since the mint oil is used primarily for flavoring confectioneries and to a small extent for drug purposes, flavor, cleanliness, and purity are vital in the production of mint oil. The buyer of mint oil that is to be used for chewing gum, confectioneries, dentifrices and various flavors, evaluates the oil on the basis of flavor and odor rather than on the basis of chemical composition. In order to insure this high quality of flavor and odor, the grower not only must keep the mint free from weeds which might produce unfavorable colors, odors or flavors during the distillation process, but



Aerial view of the Broadview Farming Company Mint Distillery, largest independently owned mint still in the world *(Photo courtesy of Broadview Farms)*

must be certain that the crop is produced under the cleanest conditions possible.

Cleanliness is essential in the oil industry, particularly in the distillation process. The truck tanks and other portions of the still and condensers are so constructed that they may be easily cleaned. Allowing the mint forage to remain in the distilling process for a longer period than is required to remove the oil may also produce an undesirable flavor, odor, or color. The quality of the oil cannot be sacrificed to a large per-acre yield. Considerable skill is required to produce quality mint oil.

So far the Yakima Valley has been relatively free from plant diseases which have presented serious problems in the mint growing areas of the Midwest. The principal disease, venticillium wilt, is present in peppermint in a very minor way, but is nonexistent with spearmint. Although spraying is practiced, pest and disease control measures can best be obtained through practicing a sound crop rotation program. Irrigated agriculture allows mint to be grown in rotation with alfalfa, corn, sugar beets, and other row crops. The minimum life of a mint field is approximately 5 years under irrigation in the Yakima Valley and some fields have a maximum life of 15 years.

The refuse from the mint forage after distillation is often spread back on to the land in its raw

Continued on page 104

Western Snow Conference

FOR MORE THAN A QUARTER CENTURY, the Western Snow Conference has been a vehicle by which leaders in water development, management and use in the western United States and Canada could keep apace with progress.

The last (April 12–14) 3-day session in Santa Fe, N. Mex., the 100 or more attending delegates agreed, was no less rewarding than the best of the 27 such sessions that had gone before.

They learned of:

—Use of electronic computers for shortcutting the tedious job of predicting runoff accurately.

—New devices for checking on and recording the varying changes in weather and water.

—How Europeans have been rigging defenses against dreaded avalanches and how Canadian highway engineers are working out avalanche protection for the treacherous Rogers Pass.

—And what studies have shown to be the trends for precipitation in western Arizona and New Mexico.

—Prospects for affecting quantity and timing of water yield through snowpack management.

—Progress in the search for a practical, low-cost means of reducing reservoir evaporation.

—New pushbutton methods for keeping tab on snowpack, air temperatures, snow quality, and soil moisture.

Of course, there were other topics, mostly hinging on the use of forecast information on snowmelt and runoff, all gathered through painstaking, regular checking of the nearly 1,500 snow courses in the high mountains. This information is gathered systematically each winter and early spring by the teams of trained snow surveyors, furnished by cooperating Federal and State agencies. Snow surveys and runoff forecasts in California are under the direction of the State's Department of Water Resources, and in British Columbia within the Department of Lands and Forests of the Province. The U.S. Soil Conservation Service is assigned leadership in the annual snow survey and forecasting work.

A paper by Hubert Ball, chief engineer of the Middle Rio Grande Conservancy District, described the use his district makes of runoff forecast information. Then he added the thought, which set off spirited discussion, that wind currents generated by adjoining watersheds may be a factor now being overlooked in the prediction of snowmelt and stream discharges. His organization keeps a watchful eye on all conditions affecting Rio Grande flow, seeking to carry out the most efficient flood control, irrigation and drainage service possible in the area, his paper pointed out.

John T. Martin of Albuquerque, N. Mex., chief

by R. A. WORK, Head, Water Supply Forecasting Unit, U.S. Soil Conservation Service

of the Corps of Engineers' hydraulic section, outlined the factors that guide his staff, in addition to the snowmelt forecasts, in gearing the Corps' reservoir system to possible emergency as well as routine use conditions. He listed the Bureau of Reclamation's authorized Wagon Wheel Gap Reservoir near Del Norte, Colo., and Abiquiu Reservoir now being built by the Corps on the Chama River in New Mexico as the type of projects which will help materially to stabilize the Rio Grande.

Walter U. Garstka of Denver, chief of the Bureau of Reclamation's chemical engineering laboratory branch, told the conference that the physical principles of using a protective film to reduce evaporation from reservoirs are sound and have been demonstrated beyond any doubt.

Evaporation losses from large reservoirs can be tremendous, Garstka pointed out. The loss from Lake Mead, for example, is between 700,000 and 900,000 acre-feet a year. The use of the monomolecular film in experiments has been shown to be effective enough to be economically feasible, Garstka added.

Results of water quality studies show no adverse effects on humans, nor has any ill effects on fish, animals, or birdlife been noted, the speaker said.

"In fact," he said, "fish seem to like the stuff. They eat it when they can see it."

Two speakers on problems of avalanche control drew rapt attention. They were Peter A. Schaerer of the National Research Council, Ottawa, Canada, and H. Martinelli, Jr., of the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Schaerer told how his countrymen are planning defense of the Trans-Canada Highway at Rogers Pass against the damaging winter slides. The pass is in the lofty and always beautiful Selkirk Range. The toll in lives claimed by the pass since the early days has been tragic.

The Canadian highway builders surveyed the avalanches and recorded them, Schaerer said. They planned a defense for each site, snow sheds for the courses of the big avalanches, earth mounds and dams for the smaller.

Martinelli reviewed the kinds of defense Europeans have been throwing up against the avalanche threat in their many mountain areas. The structures are in three classes: those built in the slide path to pin the snow to its original bed, those which are mainly wind baffles to create wind turbulence and thus guide the snow into particular areas, and, third, those which are mainly earth and masonry barriers.

Martinelli explained that trees soon become reestablished in many of the slide areas and that reforestation is a going program in many of the countries. The young trees on the steep slopes need special protection, not only from the avalanches but from snow "creep." This settling of snow strips off limbs, bends the seedlings or, in many cases, pulls them out of the soil. # # #

GLEN CANYON

Last June 17, Secretary of the Interior Seaton tripped a lever releasing the first bucket of concrete into the foundation of Glen Canyon Dam. These 12 cubic yards of concrete are the first of almost 5 million yards to be placed in this giant dam across the Colorado River in northern Arizona.

Almost 3 years of preliminary construction work had been completed prior to the concrete placement. About 30 percent of the $108 million prime contract has been completed by the Merritt-Chapman & Scott Corp.

The most striking feature of the construction site is the huge excavation for the dam. Starting at the top of each canyon wall as 200-foot deep notches into the orange sandstone rims, both keyways drop almost vertically for hundreds of feet before sloping inward to meet on the canyon floor. In the center, the foundation of the dam widens to almost 295 feet at the base and is about 125 feet below the former riverbed. From this point, the concrete arch dam will rise 710 feet to a width of only 25 feet at its narrowest point near the crest.

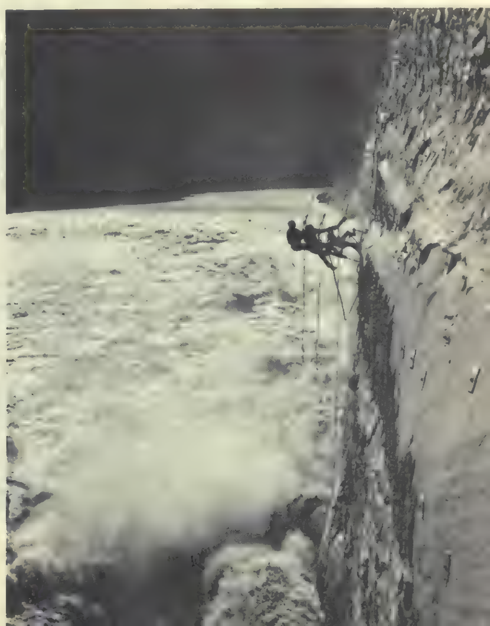
The foundation excavation for the powerplant stretches from wall to wall across Glen Canyon, just downstream from the dam. On the east is a tier of carved steps, each 10 feet high, which will receive the mass concrete encasing the outlet pipes. To the west, and spanning the remainder of the powerplant area, are the broader benches of rock, ready to support the foundation of the eight 112,-

by E. D. REYNOLDS, Civil Engineer,
Bureau of Reclamation, Page, Ariz.

MORSE "SPIKE" HEATON, Bureau of Reclamation guide, and his horse, Gunsmoke, look over organized clutter at Glen Canyon Dam site. *All photos in this article by A. E. Turner, Region 4.*

WHITE CLOUDS OF DUST AND SMOKE form a picturesque pattern after a shot in the east keyway excavation at Glen Canyon.

Highscalers drill on Glen Canyon wall just above rushing water as it pours from right diversion tunnel.



Transfer ladle car dumps its load of concrete into the 12-yard bucket high over Glen Canyon Damsite.

Section of residential area at Page, Ariz., looking up Date Street from its intersection with Navajo Drive.

500-kw. generators.

Almost 2½ million cubic yards of sandstone have been carefully blasted from the canyon walls and floor in excavation for the dam. Portions of the shattered rock were hauled to the upstream and downstream ends of the foundation area and placed in cofferdams to deny the Colorado the use of its prehistoric riverbed. The turbulent river is diverted through two concrete-lined tunnels on either side of the canyon; each tunnel is 41 feet in diameter and a half mile in length.

Both the diversion tunnels are intercepted midway down their length by a spillway tunnel. These tunnels rise sharply on a 55° angle to the surface upstream from the dam and near the canyon rim. Capable of handling a combined flood water discharge of 276,000 cubic feet per second, these tunnels will serve as emergency outlets when the reservoir is full.

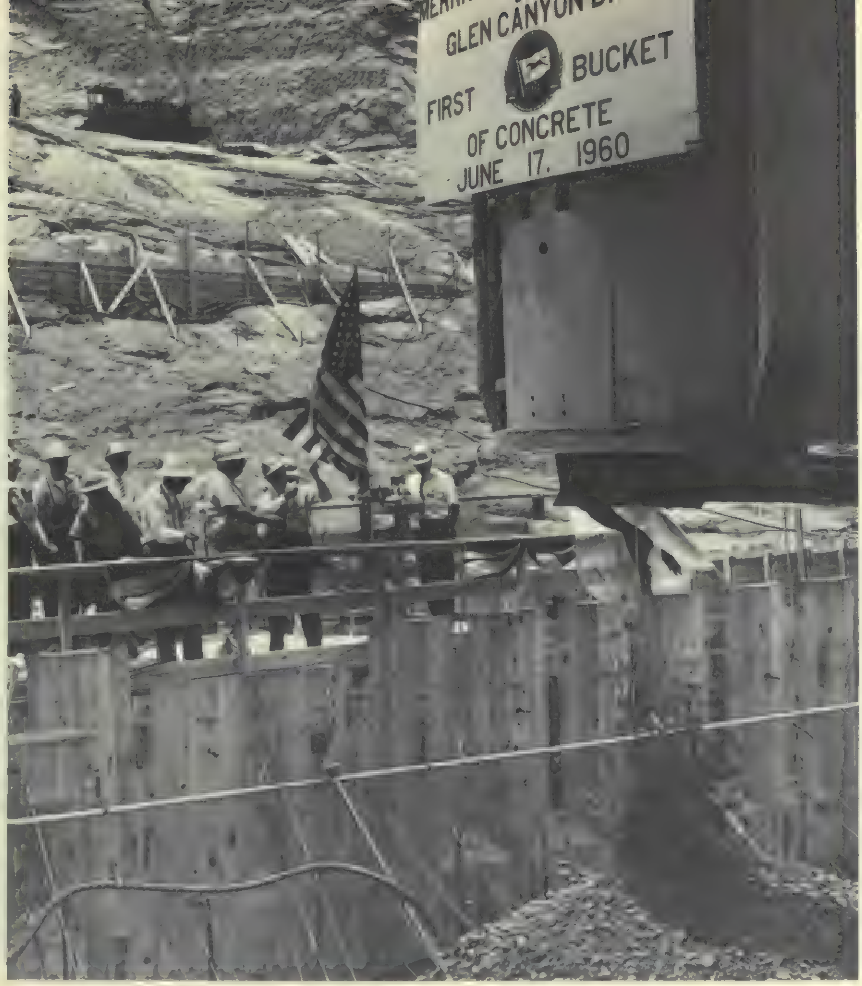
Vehicular access to the worksite is provided by another tunnel, 20 feet wide and almost 2 miles in length. Ventilation is made through large openings, called adits, which are located every 500 feet along the asphalt-surfaced roadway.

Concrete is delivered to the floor of the canyon in 12-cubic-yard buckets on two 50-ton traveling cableways. Mixed concrete is made at a 217-foot-high batch plant built on a ledge near the west keyway. This plant is capable of producing a maximum of more than 9,000 cubic yards of concrete each day.

The project's aggregate deposit is about 6 miles north of the site along Wahweap Creek. The various-sized rock is processed there and hauled by truck to a storage site near the dam.

Cementing materials—pozzolan and cement—are stored at the site in seven 10,000-barrel-capacity silos. Large as they may appear, these silos hold only a 10-day supply of these materials at peak concrete production. Cement is produced 188 miles from the project at Clarkdale, Ariz. Pozzolan, also delivered by truck, is processed from natural volcanic deposits located 110 miles south of the site.

Road access to the project was of prime importance. The Glen Canyon Bridge—highest steel arch bridge in the world—was opened for public use in February 1959. The $5 million steel span stands 700 feet above the river. Joint financing was provided by the Bureau of Public Roads, the State of Arizona, and the Bureau of Reclamation. The 1,200-foot-long bridge is now a main link on



Secretary of Interior FRED A. SEATON pulls the lanyard tripping the bucket and releasing the first 12 yards of concrete onto the floor of Glen Canyon Dam.

U.S. Highway 89 between Utah and Arizona.

Other service facilities necessary for the conduct of sustained construction have been completed, such as warehousing and storage yards, concrete testing facilities, a seismograph station, and various administration buildings.

Contracts to supply the many different types of materials and equipment for the dam and powerplant are being awarded. Deliveries are geared to the overall construction schedule. Some of the larger contracts are: $9.7 million for cement, $2.5 million for pozzolan, $3.8 million for penstocks and outlet pipes, $1.3 million for gates and hoists, and $6.4 million for turbines. Delivery of cement, pozzolan, penstocks, and outlet pipes to the site is now well underway. The huge generator contract, substantially larger than any of the above, is yet to be awarded.

Manufacture of the thousands of items required for the construction of Glen Canyon is being done in virtually every State in the Nation and some foreign countries. Fabricated steel arrives from Alabama; pipe and tubing is shipped from Florida; explosives are trucked from Missouri; New Jersey electrical products and Oregon lumber are transported by train. The list of materials grows daily, increasing with the tempo of the construction schedule.

Locally, the project provides a strong addition to a booming southwestern economy. An entirely new cement plant has been built on the basis of the project contract. This permanent plant will continue to serve the construction industry in Arizona and surrounding States in their future growth. California's growing steel industry is participating in almost $5 million worth of steel fabrication contracts. Employees of the prime contractor,

Continued on page 104

Frost Protection By Flying

Frost protection through the use of airplanes or helicopters, though still largely in the experimental stages, has definite possibilities for successful usage in many localities. The feasibility of this unique method of frost control has been conclusively demonstrated at various times and places in Arizona. It has been tried, to a very limited extent, in California.

Most of the flying, so far, has been done on produce with crop dusting planes. Virgil Koenig, crop duster pilot and also an owner of a crop dusting business in Casa Grande, Ariz., flew potato fields in 1957 and 1958. Weather conditions in 1959 did not require protection for potatoes. With one plane he took care of 320 acres, which were divided into 2 fields about 5 miles apart. Three more of his planes flew a total of 400 acres of various small fields which were separated by greater distances. Flying was done five to seven times during the growing season. The time of flying was from about 1 hour before daybreak and for 1½ to 2 hours at a time.

When a farmer is depending on this type of frost protection, he calls the pilot, or pilots, to ferry to the field and stand by, whenever temperatures begin dropping to the danger point. He stays in the field with a thermometer and signals them to go up at just the right time.

The flying is done at inversion level height, which can be from 20 to 50 feet, depending on existing weather conditions. The inversion level is where the layer of cold air from the ground meets the layer of warm air from above. A pilot in an open cockpit can easily feel where this conversion level is. The plane churns the air as it moves it forward, forcing the warm air down through the layer of cold air. A loose flying pattern is used of approximately 100-foot swaths or circles.

For lights, old automobile tires are usually set afire at each corner of the field. The pilots say that this gives adequate lighting for determining the boundaries of the fields. Tractor lights, or many other kinds of lights, could be used. One

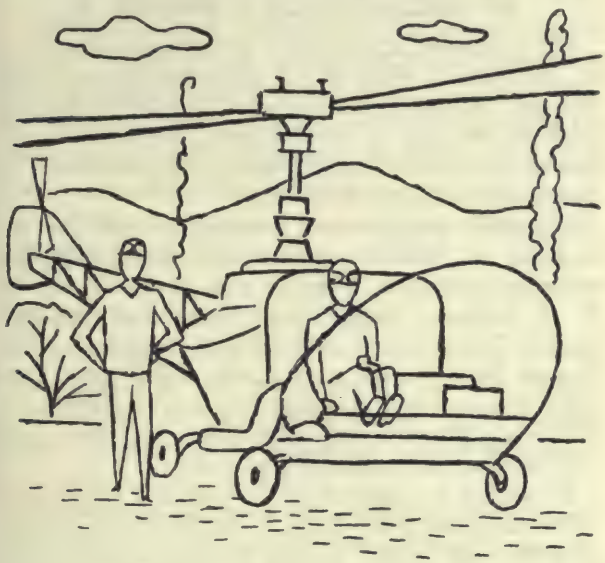
by MRS. SUSAN WILLIAMS, Wellton-Mohawk Irrigation and Drainage District, Wellton, Ariz.

advantage of tire or wood fires is that the smoke from these fires breaks at the inversion level which indicates to the pilot just where it is. Someone on the ground with a thermometer signals when it is safe to quit flying.

Gil Mayer, also a crop duster and owner of a dusting business, in Coolidge, Ariz., has done flying on melon fields. He used one plane for every 160 acres. He flew for about 2 hours at a time, beginning an hour before daybreak. Neither he nor Koenig flew by instruments. Neither of them seems to feel that this type of flying is particularly dangerous, at least no more so than crop dusting. Each charges $50 per hour.

While frost protection flying has largely been done so far on vegetables, melons or citrus, it is occasionally done on other crops. Dick Fie, of the Salt River Valley, Central Arizona, had his barley fields flown last year.

Mike Macchiaroli, owner of the James Macchiaroli Fruit Co., of the Salt River Valley, states that he is completely satisfied with the protection he got from having his 150 acres of citrus groves flown with helicopters this past winter. The work



was done for him by Blakely Aircraft Inc., of Mesa, Ariz. Two Bell helicopters were used, one a little larger than the other. None of the trees that were flown showed any sign of frost during the winter.

The flying was done at about 50 feet, approximately 25 feet over the tops of the trees. Flying time was for about 3 hours from 5 a.m. to 8 a.m. Air speed was 12 to 15 miles an hour. Helicopter flying furnishes excellent control because of the air movement. Jack Holefelder, Chief Pilot for Blakely Aircraft, says that a helicopter will create a 40-mile-an-hour downdraft which forces the warm air all the way through the trees to the ground.

Macchiaroli once used helicopters in Lode, Calif., to fly over grape vineyards after a rain to dry the water off the grapes to keep them from blistering. According to Holefelder, this has also been done on cherry orchards.

In Coachella Valley, Calif., last winer, Yeji Kitagawa used a Steerman crop dusting plane on vegetables to spread the heat from smudge pots. This was done three times during the winter. Kitagawa said that he felt the flying gave a great deal of added frost protection, but that blowing all the smoke from the smudge pots around made it difficult for the pilot to see. Mr. Kitagawa said he believed that a helicopter would be much better because it could fly at a higher altitude and still give as much air movement.

It is the consensus of many citrus authorities, including Dr. Ross Rodney, Agriculture Extension Service, University of Arizona, Dr. Alton H. Finch, of Yuma, Ariz., R. G. Platt, Extension Sub-Tropical Horticulturist, University of California, and Bert Farmer of Coachella Valley, Calif., that flying on frost protection, especially with the use of helicopters, would be much more effective and much cheaper than wind machines wherever local conditions make it practical.

Arizona growers and others of relatively isolated areas have definite advantages over those in more congested areas. There are few high powerlines, tall trees, buildings and other obstructions to interfere with flying. Arizona's low temperatures are infrequent and of short duration. Also, most of the fields and groves are of sufficient acreage to warrant the hiring of planes and pilots.

It costs approximately $4,000 for each 10 acres to set up a grove with wind machines. A grower with as much as 100 to 200 acres might well decide that the purchase of a plane or helicopter would be cheaper. In addition to frost protection, he could also spray or dust his groves and other crops with the same plane as well as using it for custom work and for transportation.

For tax purposes, a plane can be set up on a high depreciable basis. If the flying is hired from custom operators, it is deductible on a yearly basis.

In conclusion, it seems reasonable to believe that the flying of frost protection might have a place in the agriculture programs of the future.

# # #

Dancing on the mint hay to compress it into the distiller (*Photo by Rasmussen*)

MINT CAPITAL

Continued from page 94

form or placed in a compost pile and later applied to the land. Some experiments have been conducted recently on feeding the refuse to livestock and preliminary results appear to be promising.

How long the Yakima Valley will retain the honor of the world's mint capital remains to be seen but it appears to be in no immediate danger of losing its title. Undoubtedly, as more land is developed under irrigation in the Northwest, mint production will increase and its production will become more widespread. # # #

GLEN CANYON

Continued from page 101

Merritt-Chapman & Scott Corp., now number over 1,300. They anticipate that between 1,800 and 2,000 employees will be required at peak construction.

The remoteness of Glen Canyon made it necessary to build housing facilities for the use of construction employees, with some permanent houses for employees who will operate the dam and powerplant. Substantial completion of Government facilities in the town of Page was accomplished in 1959. Residential and commercial properties are now available for sale to private individuals. As the orderly development progresses, a modern city emerges from the barren desert.

As you read this article, concrete is being mixed and placed in Glen Canyon Dam, racing against time toward the 1964 completion date. Great blocks of concrete rise scores of feet above the canyon floor in a massive checkerboard pattern. Another link is being forged in the chain of control on the mighty Colorado River. # # #

ASSISTANT DIRECTOR NAMED FOR BUREAU OF RECLAMATION'S REGION 4

C. S. Rippon, formerly Construction Engineer on the Glendo Unit of the Missouri River Basin Project, was named Assistant Director of Region 4 of the Bureau of Reclamation, with headquarters in Salt Lake City, Utah, by Commissioner of Reclamation Floyd E. Dominy.

Rippon's appointment coincided with the retirement of Reid Jerman as head of Project Development in the Region, and the transfer of P. B. DeLong to that post from Assistant Regional Director. F. M. Clinton is Director of Region Four, which administers the Upper Colorado River Basin Storage Project in Colorado, Wyoming, New Mexico, and Utah; and the adjacent Bonneville Basin area in Utah.

Rippon is a native of Utah, born in Coalville in 1909, and graduated from Utah State University in 1931 with a B.S. degree in civil engineering. He started work with the Bureau of Reclamation as a junior engineer in the Design Section of the Chief Engineer's Office in Denver in August of 1931, and has been constantly associated with the Bureau since.

He has worked on construction jobs at the Seminoe Dam in Wyoming, the Tucumcari Project in New Mexico, Shasta Dam in California, and Hoover Dam on the lower Colorado River between Nevada and Arizona. # # #

CARL MOODY (*Photo by A. E. Turner, Region 4*)

HIRE THE HANDICAPPED

CARL MOODY, a signalman for the contractor at Glen Canyon Dam, is without hands, and has only the stump of one arm. But there is no one who could doubt his ability to do his job—and to do it well. Carl lost his hands at the age of 13 when he accidentally touched a 2,300-volt power line. From that time on, he has been determined to master every skill that he could.

When he was 15, he won a marble contest PLAYING WITH HIS TOES!

He practiced each skill in the privacy of his father's garage until he could do it well. Then he displayed his ability to others. In his own words, "A man can do anything if he works hard enough."

He now can shoot a rifle (pulling the trigger with a string in his teeth), write, drive a car, and perform hundreds of everyday skills most of us take for granted.

In the '30's, he owned a grocery store in Oklahoma. Later, during the war, he began following heavy construction, and has worked all over the West in dam and road construction. Some of his duties included road foreman, excavation superintendent, and camp superintendent. He has worked on Corps of Engineers dams, private utility dams, and Bureau of Reclamation dams. In February 1958, he moved to Page, Ariz., to work for the prime contractor on Glen Canyon Dam, Merritt-Chapman & Scott Corp.

His job is to direct the movements of the huge

The 16th National Employ the Physically Handicapped Week has been designated as the week beginning October 2 by President Dwight D. Eisenhower. This is the 16th year in which the "Week," which only emphasizes the problem, has been observed. The President in his proclamation stated partially: " * * The expanding national program to develop maximum employment opportunities for the physically handicapped is continuing to attract the interest of additional thousands of dedicated volunteers in national, State, and community committees who are working wholeheartedly with public and private agencies for the rehabilitation and employment of handicapped persons * * *" This is an account of a few persons working in the Reclamation area.*

JULIUS MARTH

cableways operating over the canyon. An error on his part could result in serious accident to men or in loss of equipment.

The Nation's first multiplepurpose reclamation project—The Salt River Project—has always found that hiring the handicapped is good business. A case in point is the experience of JULIUS MARTH, now the field representative and Assistant Office Manager for the Project's Credit Union. Eighteen years ago, Julius lost his right leg in an automobile accident. Today he will tell you that he never even thinks about it.

Like most people with a considerable adjustment to make toward their physical condition, Julius Marth would like to forget about it. As a matter of fact, even an article of this nature usually has to be put together over the protest of the subject that he not be given any publicity or sympathy. Strangely enough, these articles usually run counter to the philosophy of the so-called handicapped person by drawing attention to the handicap rather than away from it. After all, being handicapped is a purely relative thing. A person's age can be a serious handicap, or his color, or his weight, or his height. Yet the loss of limb appears as a more dramatic handicap and as a result is often thought to be more serious by some employers.

This has not been true at the Salt River Project and Julius Marth's record will bear this out. The 48-year-old native of St. Louis now leads a full life. He gets around as much as anyone in this writer's acquaintance, works in the yard, and indulges himself in some carpentry around the house. Julius Marth came with the Project in December of 1951.

WAYNE E. BREWER is employed in a training capacity, as an accountant GS–7, in the Washita Basin Project headquarters office at Anadarko, Okla. He contracted polio at the age of about 3½ years, and was in a hospital the major part of 6 years. His mobility is dependent on leg braces and crutches; however, he is quite active and independent.

Mr. Brewer graduated from high school at Roswell, N. Mex., in 1954, and was awarded a BBA degree from the University of New Mexico in June 1958, majoring in accounting. Very soon thereafter he accepted employment in the Finance Section of the Middle Rio Grande Project at Albuquerque, N. Mex., and in January 1960 he transferred to this project.

He has a pleasing personality, and those who come in contact with him consider him industrious and efficient. One of his hobbies is leathercraft, and he enjoys outdoor recreation and sports. He was born in Paris, Tex., but very early in life moved to Roswell, and he drives his own car there for visits, as well as other recreational spots.

# # #

WAYNE E. BREWER

water report

Irrigation water shortages were general in most of the western United States in 1960. Shortages were most evident along small tributaries with little or no storage. Even on the larger streams, with substantial reservoir capacity, storage was depleted to meet water demands during the summer. Irrigation water use during June, July and August was well above average to make up for deficiencies in summer rainfall. The trend of streamflow during the summer followed that indicated by forecasts based on mountain snow and soil moisture measurements by the Soil Conservation Service and its cooperators [1] last April 1 and May 1. Streamflow tended to be slightly less than that forecast because of the extreme deficiencies in precipitation during the summer. This deficiency was west-wide in scope.

Most severe shortages of irrigation water supplies occurred over the Great Basin in Nevada, Utah and southeastern Oregon. Similar conditions are reported in adjacent regions for the Snake river tributaries in southern Idaho and the southern half of the Central Valley of California. Streamflow was less than half of normal. Reservoirs were empty before the crops matured. Extensive use was made of groundwater supplies where available. Adjustments in crop acreage, based on forecasts last spring, have been observed and reported. Losses could have been more extensive if these adjustments had not been made.

Water supplies were generally adequate in Washington, northern Idaho and western Montana, even though streamflow was less than average. Some shortages did occur on the Wind River drainage and east of the Bighorn range in Wyoming. Irrigation requirements generally were met along the Platte rivers in Colorado and Wyoming by using storage and transmountain diver-

[1] The Soil Conservation Service coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal Bureaus, various departments of the several states, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that state, contributed the California information.

by HOMER J. STOCKWELL, Water Supply Forecast Unit, Soil Conservation Service, Portland, Oregon, and ROBERT T. DAVIS, Snow Survey Supervisor, Soil Conservation Service, Spokane, Washington

sions. Local late season shortage occurred on Colorado River tributaries.

The flow of the Rio Grande in New Mexico and west Texas was below normal and less than anticipated. Crop production was maintained by using supplemental groundwater. In Arizona, Salt River Valley irrigation water supplies were reasonably satisfactory as compared to recent years, even though the summer rainfall was extremely low. Streamflow was well above normal in early season and substantially above average reservoir storage was available.

This article for RECLAMATION ERA was prepared under the supervision of *R. A. WORK*, Head, Water Supply Forecast Unit, Soil Conservation Service, Portland, Oreg., based on information supplied by snow survey supervisors of the Soil Conservation Service.

Water users have real concern over the outlook for 1961. Should fall rainfall and winter snowpack be deficient the irrigation water shortage for next year will be one of the most extensive in recent times. Individual areas have experienced more limited water supplies, but it is doubtful if these prospective shortages have been as widespread since the middle 1930's.

Reservoir storage is generally down, even in large reservoirs on the upper reaches of major streams. Watersheds where the snow will fall this winter are extremely dry. Unless fall precipitation improves, much of next winter's snowpack will be used to replace mountain soil moisture before it is available for runoff. Water users will find it advantageous to follow closely the reports on snow conditions this coming winter.

In the following paragraphs, water conditions by states are briefly reviewed, emphasizing conditions that affect the 1961 water supply outlook.

Arizona.—The heavy snowpack of last winter resulted in a runoff of about 130 percent of normal for the irrigation season. July and August rainfall was extremely deficient. Minimum record low flows on the Salt, Verde, Gila, and Little Colorado rivers were experienced during these months.

Because of high early season flows there was an adequate water supply for most areas. Considerable pumping was necessary in the upper valleys where no storage is available.

The Salt and Verde reservoirs contain nearly twice the normal storage for this date. San Carlos Reservoir on the Gila is nearly empty which has been the usual situation in recent years.

Watershed soils are dry throughout the state following deficient summer precipitation. Heavy fall and winter precipitation will be necessary to ensure a normal runoff in the spring of 1961.

California.—The California Department of Water Resources reports that the water year ending September 30, 1960 was among the driest of record throughout much of California. Precipitation, runoff and snowpack were all below average.

Water supply in the extreme northern portion of the state was much better than elsewhere, although still well below average. Although streamflow during 1959–60 was somewhat greater than during the previous year, the cumulative effects of two sub-normal water supply years have accentuated the need for development of new supplies. Many local water shortages have developed and groundwater levels have been lowered.

Precipitation during 1959–60 varied from 70 percent of normal in the southern portion of the State to 90 percent in the extreme northern portion. These precipitation figures tend to give an overly optimistic picture of water conditions since they include heavy precipitation which occurred late in September 1959. This precipitation did not contribute much to water supplies because of the extremely dry conditions which developed during the October-December period. Late winter and spring precipitation was far below average throughout the state.

This year the April-July runoff in major Central Valley streams was 7,828,000 acre-feet compared to a runoff last year of 6,625,000 acre-feet and an average runoff of 13,719,000 acre-feet. April-July runoff on major streams in this area ranges from 75 percent of average on the Sacramento River in the north to 35 percent on the Kern River in the southern extreme of the basin.

Outflow to San Francisco Bay from the Central Valley during the 1959–60 water year was about 9 million acre-feet as compared to 10,500,000 acre-feet during 1958–59, and an average outflow of about 20 million acre-feet. Outflow from this area during 1959–60 was the sixth lowest in the last 30 years of record.

Groundwater levels in the Central Valley have fallen an average of about three feet since last fall and in some areas has dropped as much as 16 feet.

On October 1, 1960 there were 6,300,000 acre-feet of water stored in the 44 major reservoirs serving the Central Valley as compared to 5,950,000 acre-feet on October 1, 1959. The 1960 figure is about 80 percent of the past 10-year average and 45 percent of the usable capacity.

Although a number of years during the past one-half century have had runoff as low or lower than that of the last two water years, increased population and intensified use of water during recent years have amplified problems resulting from short water supply. Only through systematic development of additional reservoir storage and judicious use of existing storage facilities can the increased demand for water be met in this state.

Colorado.—There was only a small reduction of irrigated crops due to lack of water in Colorado. Precipitation was light in most areas during the summer which increased the demands on irrigation systems. Where storage was available, water supply was generally adequate. In groundwater districts, pumping was heavy.

Streamflows this year were near normal on the upper South Platte, Rio Grande, and upper Colorado basins and their tributaries. Some shortages occurred in the Cortez area served by the Dolores River. Reservoir storage is less than a year ago and about 75 percent of normal.

Watershed soils are generally dry throughout the state in direct contrast to a year ago. Heavy snows are needed this winter to insure adequate irrigation water next year.

Idaho.—Snowfall during the winter of 1959–60 was near a minimum of record for Snake River tributaries in southern Idaho. This indicated a critical water shortage on the smaller rivers with limited storage.

A substantial reduction in plantings to heavy water using crops occurred in these water-short areas. Significant savings resulted from adjusting the amount of land to be irrigated in accordance with water supply forecasts.

On the major rivers in Idaho, such as the Snake, Boise, and Payette, reservoir-stored water provided normal irrigation supplies, but storage has been seriously depleted. Practically all small irrigation reservoirs in the State are empty.

Soils on Idaho watersheds are the driest on record. Much above normal precipitation from now until snowfall, and a heavy snowpack, will be necessary to produce even normal streamflow for 1961.

Kansas.—As anticipated, water supply for the area below John Martin Reservoir was below normal. The runoff of the Arkansas River was augmented by heavy pump-

(Continued on page 110)

Water stored in western reservoirs

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Aug. 31, 1959	Aug. 31, 1960
Region 1	Baker	Thief Valley	17,400	9,500	(1)
	Bitter Root	Lake Como	34,800	12,000	5,000
	Boise	Anderson Ranch	423,200	341,900	302,500
		Arrowrock	286,600	5,800	5,800
		Cascade	654,100	488,400	416,700
		Deadwood	161,900	49,800	107,200
		Lake Lowell	169,000	32,000	44,500
		Lucky Peak	278,200	187,500	187,000
	Burnt River	Unity	25,200	4,400	4,000
	Columbia Basin	F. D. Roosevelt Lake	5,072,000	5,225,000	5,181,000
		Banks Lake	761,800	625,700	623,000
		Potholes	470,000	135,000	83,100
	Deschutes	Crane Prairie	55,300	20,000	21,000
		Wickiup	187,300	29,000	20,000
	Hungry Horse	Hungry Horse	2,982,000	3,004,600	2,993,500
	Minidoka	American Falls	1,700,000	112,500	117,300
		Grassy Lake	15,200	6,300	4,400
		Island Park	127,200	38,600	29,900
		Jackson Lake	847,000	641,700	604,800
		Lake Walcott	95,200	83,400	92,900
	Ochoco	Ochoco	47,500	4,800	(1)
	Okanogan	Conconully	13,000	7,100	4,800
		Salmon Lake	10,500	10,300	10,300
	Owyhee	Owyhee	715,000	191,700	229,500
	Palisades	Palisades	1,202,000	686,900	149,200
	Umatilla	Cold Springs	50,000	6,900	7,900
		McKay	73,800	12,900	12,100
	Vale	Agency Valley	60,000	10,400	14,000
		Warm Springs	191,000	24,600	30,000
	Yakima	Bumping Lake	33,700	12,700	9,900
		Clear Creek	5,300	5,300	5,300
		Cle Elum	436,900	249,600	215,300
		Kachess	239,000	173,100	155,300
		Keechelus	157,800	94,300	66,800
		Rimrock Lake	198,000	104,900	67,900
Region 2	Cachuma	Cachuma	201,800	186,800	163,200
	Central Valley	Folsom [2]	920,300	284,200	501,500
		Jenkinson Lake	40,600	29,200	24,400
		Keswick	20,000	19,800	19,200
		Lake Natoma	8,800	8,500	1,300
		Millerton Lake	427,800	59,100	66,000
		Shasta Lake	3,998,000	2,157,300	2,457,900
		Lake Thomas A. Edison	125,100	74,700	59,400
	Humboldt	Rye Patch	190,000	25,900	4,200
	Klamath	Clear Lake	513,300	186,100	116,200
		Gerber	94,300	8,900	4,700
		Upper Klamath Lake	524,800	189,600	185,900
	Newlands	Lahontan	290,900	44,500	34,100
		Lake Tahoe	732,000	469,200	234,000
	Orland	East Park	50,600	1,600	10,500
		Stony Gorge	50,000	24,200	21,200
	Truckee Storage	Boca	40,900	1,000	6,600
Region 3	Boulder Canyon	Lake Mead	27,207,000	20,617,000	20,557,000
	Parker-Davis	Havasu Lake	216,500	108,700	122,600
		Lake Mohave	1,809,800	1,388,700	1,390,400
	Salt River	Apache Lake	245,100	242,000	241,000
		Bartlett	179,500	39,000	14,000
		Canyon Lake	57,900	54,000	52,000
		Horseshoe	142,800	14,000	5,000
		Theodore Roosevelt Lake	1,381,600	223,000	922,000
		Sahuaro Lake	69,800	43,000	37,000
Region 4	Eden	Big Sandy	38,300	500	1,000
	Fruitgrowers Dam	Fruitgrowers	4,500	800	800
	Hyrum	Hyrum	15,300	3,700	1,600
	Mancos	Jackson Gulch	9,800	800	4,400
	Moon Lake	Midview	5,800	3,000	(1)
		Moon Lake	35,800	2,100	(1)
	Newton	Newton	5,400	400	300
	Ogden River	Pineview	110,200	9,100	19,600
	Pine River	Vallecito	126,300	30,400	61,900
	Provo River	Deer Creek	149,700	67,000	70,000
	Scofield	Scofield	65,800	13,700	2,300
	Strawberry Valley	Strawberry Valley	270,000	108,500	56,000
	Uncompahgre	Taylor Park	106,200	61,700	68,600
	Weber River	Echo	73,900	15,700	12,300
Region 5	W. C. Austin	Altus	162,000	103,100	119,900
	Balmorhea	Lower Parks	6,500	200	6,800
	Carlsbad	Alamogordo	122,100	104,500	120,500
		Avalon	6,000	1,400	1,600
		McMillan	32,300	22,200	29,100
	Colorado River	Marshall Ford	1,837,100	724,700	665,900
	Middle Rio Grande	El Vado	194,500	20,200	21,200
	Rio Grande	Caballo	340,900	55,400	28,500
		Elephant Butte	2,185,400	575,300	408,800
	San Luis Valley	Platoro	60,000	4,000	11,500
	Tucumcari	Conchas [3]	467,300	245,500	248,000
	Vermejo	Reservoir No. 2	2,900	2,000	1,200
		Reservoir No. 13	5,000	3,200	4,500
		Stubblefield	16,100	6,400	3,400

See footnotes at end of table.

Water stored in western reservoirs—Continued

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	Aug. 31, 1960	Aug. 31, 1959
Region 6	Missouri River	Angostura	92,000	20,000	2,900
		Boysen	710,000	211,800	36,600
		Canyon Ferry	1,615,000	1,516,400	1,327,200
		Dickinson	13,500	3,400	4,500
		Fort Randall [2]	4,900,000	2,394,900	2,824,200
		Garrison [2]	18,100,000	4,746,000	6,602,100
		Lake Taschida	218,700	55,300	63,400
		Jamestown	39,200	9,300	17,700
		Keyhole	190,300	500	5,100
		Lewis and Clark Lake [2]	385,000	247,700	329,800
		Pactola	55,000	20,900	17,900
		Shadehill	300,000	75,600	78,500
		Tiber	762,000	107,200	207,900
	Belle Fourche	Belle Fourche	185,200	1,500	8,200
	Fort Peck	Fort Peck [2]	14,839,000	6,446,400	7,608,100
	Milk River	Fresno	127,200	74,300	43,000
		Nelson	66,800	40,300	43,600
		Sherburne Lake	66,100	34,800	22,000
	Rapid Valley	Deerfield	15,100	3,300	2,700
	Riverton	Bull Lake	152,000	77,700	50,600
		Pilot Butte	31,600	5,200	6,400
	Shoshone	Buffalo Bill	380,300	294,500	163,100
	Sun River	Gibson	105,000	65,200	51,200
		Pishkun	30,100	25,800	6,100
		Willow Creek	32,400	6,200	14,900
Region 7	Colo.-Big Thompson	Carter Lake	108,900	41,800	30,600
		Granby	465,600	348,600	387,100
		Green Mountain	146,900	141,100	141,600
		Horsetooth	141,800	52,700	65,100
		Shadow Mountain	1,800	800	500
		Willow Creek	9,100	1,800	2,800
	Missouri River Basin	Bonny	167,200	33,300	33,100
		Cedar Bluff	363,200	174,100	194,800
		Enders	66,000	25,000	27,900
		Glendo	786,300	138,000	74,200
		Harlan County [2]	752,800	168,000	215,100
		Harry Strunk Lake	85,600	17,400	17,500
		Kirwin	304,800	71,500	79,200
		Kortes	4,500	4,400	4,400
		Lovewell	87,800	16,100	26,200
		Swanson Lake	249,800	71,000	79,500
		Webster	257,400	61,700	62,500
	Kendrick	Alcova	24,500	26,800	25,600
		Seminole	957,000	591,400	380,400
	Mirage Flats	Box Butte	30,400	9,800	8,700
	North Platte	Guernsey	39,800	23,700	6,300
		Lake Alice	11,200	3,800	3,000
		Lake Minatare	59,200	9,500	7,400
		Pathfinder	1,010,900	129,300	79,400
Alaska Dist	Eklutna	Eklutna Lake	160,000	[1]	144,000

[1] Not reported.

[2] Corps of Engineers Reservoir.

(Continued from page 108)

ing. Summer precipitation was less than normal, and soil moisture conditions are reported as fair.

Montana.—Streamflow was below average in the Missouri River drainage this season. Many prairie streams produced less than 25 percent of the average streamflow. Streamflow on the Columbia River drainages was from 80 to 100 percent of average during the April through September period.

Considering the below average snowpack last spring, and low volume of runoff, streamflow held up exceptionally well throughout the irrigation season. With the exception of the prairie streams, few areas were short of irrigation water.

Precipitation from April through September was near normal except in the North Central and Southeastern areas of the state where deficiencies were recorded.

Soils are dry throughout the state. Below normal fall precipitation and winter snowpack could result in a critical water supply next season.

Storage in irrigation reservoirs in the Missouri Basin is 65 percent of the 1943–57 average. Carryover storage is fair to good in most areas, with the exception of the southeastern portion of the state. Storage in the Columbia Basin reservoirs is near average.

Nebraska.—Storage in the Kansas River projects is 80 to 85 percent of irrigation pool level. Water supply prospects for next year are good. In the North Platte irrigated area, storage has been depleted in the large reservoirs in Wyoming, as well as in Lake Alice and Minitare. Soil moisture conditions in irrigated areas are relatively good due to recent rainfall. A heavy snowpack in the mountains of Wyoming and Colorado will be essential this winter for adequate water supplies in 1961.

Nevada.—As anticipated in early spring, runoff was much below normal in Nevada. Streamflow during April–July ranged from 68 percent of normal on Lamoille Creek to 18 percent of normal on the Carson River at Fort Churchill. Reservoirs are empty or very low except for Wildhorse, which is near average. Lake Tahoe is at the lowest level in 10 years with 222,000 acre-feet in storage.

Many acres were left fallow in order to concentrate the limited water supplies on the best lands or lands with established grass and alfalfa stands. The Fallon area, with a 70 percent water allotment, suffered no serious crop damage except for some pastures. Annual crop production in Mason and Smith valleys was 50 percent of normal. In the Lovelock area, much less land than usual was farmed in order to make better use of water. Northeast Nevada had a slightly better year than anticipated due to good April and May rainfall.

Nevada has ended the 1961 water year with extremely dry mountain and valley soils, and dry or near dry reservoirs. Unless fall rainfall is normal or better and is

followed by heavy mountain snowfall, Nevada will experience another year of drouth.

New Mexico.—Streamflow along the Rio Grande was below normal. The cool spring and lack of summer precipitation drastically reduced the expected runoff. Areas without storage suffered shortages during the late season.

There was no material reduction in crop acreage. Areas where runoff water was not available relied heavily on pumping. Carryover storage was depleted. Storage in Elephant Butte and Caballo reservoirs is 390,000 acre-feet as compared to 575,000 acre-feet at this time last year.

Water supply on the Carlsbad Project was fair. Carryover storage is slightly better than last year. Soil moisture conditions are reported as about normal.

The Arch Hurley Conservancy District had adequate water this year. Streamflow in this area was slightly below normal. Carryover storage is 236,000 acre-feet, which is about two-thirds of average.

Generally, carryover storage through the state is less than last year and soil moisture conditions are not favorable. Considerable precipitation and a heavy snowpack are needed to improve the water supply outlook for 1961.

Oklahoma.—Water supply for the W. C. Austin Project was about normal for the 1960 irrigation season. There was no reduction in crops in this area. Carryover storage in Lake Altus is better than last year. Pumping was only moderate during the year and present soil moisture conditions are about average.

Oregon.—Irrigation water supplies for the 1960 season were better than for 1959 where adequate storage was available to hold high early spring runoff. Areas of Central Oregon, which depend largely on natural streamflow, had extreme shortages, even when compared to the poor season of a year ago. Crop reports indicate a substantial decrease in total yields.

Soils on mountain watersheds are generally dry over the state as a result of a deficiency in late summer precipitation. Carryover storage is only 67 percent of average for 21 principal reservoirs. An above average snowpack will be necessary to provide normal water supplies next year.

South Dakota.—Storage in Angostura, Deerfield, and Belle Fourche reservoirs is below average at the end of the season. Shadehill storage is good. Soil moisture conditions in the Black Hills area are fair. Water outlook for next year is not too favorable.

Texas.—There was only a small reduction in irrigated crops because of water shortage in western Texas. However, this was accomplished at the expense of a considerable depletion of carryover storage in Elephant Butte Reservoir. Elephant Buttee contains 385,000 acre-feet as compared to 533,000 acre-feet at this time last year. Pumping was light to moderate.

Soil moisture conditions are reported fair to poor. Storage in Red Bluff on the Pecos is slightly higher than at this time last year.

Utah.—Much above normal temperatures, coupled with very light precipitation during the summer, caused streams to fall much more rapidly than usual, yielding less than was anticipated last spring. As forecast, snowmelt seasonal water supplies have varied from limited to severe shortages. Parts of a few northern counties had adequate water supplies. For the first time in many years the irrigated section of Cache Valley had some shortage of irrigation water. In areas where pump irrigation is used, supplies have been generally adequate, but at the expense of declining water tables.

If water supplies for 1961 are to be adequate, a much above average snowpack is needed this winter. The poor season just ending will have a major influence on next summer's water supply since reservoir storage has been severely depleted. Examples are the Sevier Bridge, Piute and Otter Creek reservoirs on the Sevier River.

Not only do the reservoirs now store less than average, but inflow this winter will be much less than average as a carryover effect from the current season.

Unless October and November are wet months, the dry soil moisture conditions will further decrease water yield from next winter's snowpack.

Washington.—Demand for irrigation water was heavy in the mid-summer months this past growing season because of the deficiency in precipitation. Generally adequate supplies have been available for all water users except where the farmers relied upon direct diversion. In many cases these irrigators without storage had to curtail their normal operations.

Runoff during the irrigation season started with flows generally above the 1943–57 normal. May had much below average flows, June near average, July below, and August normal or below. During September, streamflow was near normal.

Precipitation during the spring and summer was erratic. Heavy rainfall occurred during April, May, and the last half of August, while the remainder of the season had little or no rainfall.

Spring-fed streams which have had continuous flow for the past few years have dried up, indicating a lack of groundwater supply. This lack of soil priming, unless helped by fall precipitation, will tend to decrease runoff next year.

Reservoir carryover as of October 1 in the five Yakima reservoirs is not as good as last year, but considerably better than in the fall of 1957 and 1958.

Wyoming.—Streamflow for the irrigation season of 1960 ranged from 60 to 70 percent of normal. Water supplies were inadequate, especially along smaller streams with no storage. On the North Platte water requirements were reasonably met, but storage in the large reservoirs is at a low point. A normal or better snowpack will be necessary to provide adequate supplies for next year. Some rather extreme shortages occurred on tributaries to the Bighorn in northwestern Wyoming.

Soil moisture conditions are poor on the watersheds, except in northwestern Wyoming. Storage in Jackson Lake is near average. # # #

PLANS PROGRESS FOR NRA BAKERSFIELD MEETING

As this issue went to press, we learned that the local committee for entertainment and general arrangements has plans well worked out for another big *National Reclamation Association Convention* to be held in *Bakersfield, Calif., November 16 to 18 this year.* Headquarters will be in Bakersfield Inn.

Two deluxe tours are planned out of Bakersfield for Tuesday, November 15. One of these tours will be held in the forenoon and the other in the afternoon, thus giving those who wish to take both of the tours an opportunity to return to Bakersfield for relaxation and lunch during the noon hour. One of these tours will include a visit to the Digiorgio Farms and winery.

The NRA delegates who have over a period of years been enjoying the delicious grapes that have been made available at previous conventions by the NRA members from California will be interested in seeing where these prize grapes are produced and no doubt a few will be interested in the winery.

Kern County is widely recognized as one of the Nation's outstanding agricultural counties. Every NRA delegate regardless of whether or not he is a farmer will be especially interested in seeing this wonderful agricultural area.

Secretary-Manager William E. Welsh arranged the preliminary plans for the convention after conferring with President LeSelle Coles and other officials of the association from the various Western States. Indications were that the meeting would include nationally known authorities in the field of water resource development.

National Reclamation Association President Coles was scheduled to deliver the principal address.

In addition to President Coles, others scheduled to address the convention included leading members of the House and Senate Interior and Insular Affairs Committees; and Reclamation Commissioner Floyd E. Dominy.

Other Interior and Reclamation officials in attendance at the annual convention of the NRA were Assistant Secretary—Water and Power Development, Fred G. Aandahl; Assistant Commissioners N. B. Bennett and W. I. Palmer of Reclamation; Associate Solicitor, Water and Power, Edward W. Fisher; assistant to the Commissioner-Information, Ottis Peterson; Chief, Division of Irrigation and Land Use, Gilbert G. Stamm; and Chief, Division of Project Development, D. R. Burnett.

Lt. Gen. Emerson C. Itschner, Chief of the Army Corps of Engineers, is also expected to be present and deliver a major address. #

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-5263	Colorado River Storage, Utah-Wyo.	Aug. 12	Three 50,000-hp, vertical-shaft, hydraulic turbines for Flaming Gorge powerplant.	James Leffel & Co., Springfield, Ohio.	$798,550
DS-5277	Central Valley, Calif.	Aug. 12	Two 93,500-hp, vertical-shaft, hydraulic turbines for Clear Creek powerplant.	Hitachi New York, Ltd., New York, N.Y.	664,860
DS-5278	do	Aug. 12	Two vertical-shaft, hydraulic turbines, including 2 interchangeable runners for each turbine, 1 rated 85,000-hp at 426-foot head and 1 rated 70,000-hp at 334-foot head, for Trinity powerplant.	English Electric Export & Trading Co., Ltd., New York, N.Y.	832,830
DC-5330	Crooked River, Oreg.	July 11	Construction of Ochoco relift pumping plant and Barnes Butte pumping plant and discharge lines. Schedules 1 and 2.	Syblon-Reid Construction Co., Warden, Wash.	358,305
DC-5338	Rogue River, Oreg.	July 11	Rehabilitation of Oak Street diversion dam and Talent lateral, Sta. 3+54 to 125+68.	Riverbend Contractors, Inc., Portland, Oreg.	198,750
DC-5343	Missouri River Basin, N. Dak.	July 20	Construction of 114 miles of Garrison-Minot-Rugby 115-kv transmission line	Malcolm W. Larson Contracting Co., Denver, Colo.	1,806,171
DS-5346	Central Valley, Calif.	Aug. 12	Two 105,000-hp, vertical shaft, 225-rpm, hydraulic turbines for Spring Creek powerplant.	Newport News Shipbuilding & Dry Dock Co., Newport News, Va.	1,125,000
DS-5349	Chief Joseph Dam, Wash.	Sept. 14	Four motor-driven, horizontal, centrifugal-type pumping units for East Unit booster pumping plant. Schedule 1.	American Ligurian Co., Inc. New York, N.Y.	117,512
DC-5350	Central Valley, Calif.	Aug. 5	Construction of Whiskeytown dam	Gibbons & Reed Co., Salt Lake City, Utah.	6,215,577
DC-5351	Missouri River Basin, Wyo.	Aug. 18	Construction of 65 miles of Cheyenne-Pine Bluffs-Sidney 115-kv transmission line.	Crawford Electric Co., North Platte, Nebr.	783,41
DC-5353	Missouri River Basin, N. Dak.	Aug. 5	Construction of 110.5 miles of Jamestown-Grand Forks 115-kv transmission line No. 1.	Superior Electric Co., Appleton, Wis.	1,352,207
DS-5354	Colorado River Storage, Ariz-Utah.	Aug. 23	Twenty-three stop log sections and 1 lifting frame for penstock intakes at Glen Canyon dam. Schedule 1.	United States Steel Corp., Consolidated Western Steel Division, Los Angeles, Calif.	116,700
DS-5354	do	Aug. 23	One lot of stop log guides for penstock intakes at Glen Canyon dam. Schedule 2.	Bennett Industries, Inc., Peotone, Ill.	158,346

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Major Recent Contracts Awards—Continued

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5355	Missouri River Basin, N. Dak	Aug. 17	Constructing foundations and furnishing and erecting steel towers for 136 miles of Garrison-Jamestown 230-kv transmission line.	Electric Properties Co., Lincoln, Nebr.	1,913,500
DC-5357	Missouri River Basin, Nebr	Sept. 7	Construction of Arcadia diversion dam and Sherman Feeder canal, Sta. (−) 49+50.16 to 24+00.	Bushman Construction Co., St. Joseph, Mo.	1,093,548
DC-5359	Crooked River, Oreg	Aug. 29	Construction of earthwork and structures for distribution canal, Sta. 5+71.23 to 900+10, using either precast-concrete pressure pipe or pretensioned concrete pipe for the barrel of the siphon at Sta. 83+81. Schedule 2.	Contractors and Excavators, Inc., Helena, Mont.	332,080
DS-5363	Colorado River Storage, Ariz.-Utah.	Aug. 29	Four 96-inch hollow-jet valves for river outlets at Glen Canyon dam.	Goslin-Birmingham Mfg. Co., Ind., Birmingham, Ala.	292,200
DC-5366	Central Valley, Calif	Sept. 22	Construction of earthwork and structures, and surfacing for relocation of Trinity County road, Carrville to Cedar Creek.	O. K. Mittry & Sons, Gardena, Calif.	711,158
DC-5367	Colorado River Storage, Smith Fork Participating Project, Colo.	Sept. 16	Construction of Crawford dam	Bud King Construction Co., Missoula, Mont.	1,930,779
DC-5368	Missouri River Basin, Nebr	Sept. 20	Construction of earthwork and structures for Sherman feeder canal, Sta. 24+00 to 656+48.	Bushman Construction Co., St. Joseph, Mo.	1,818,343
DC-5384	Colorado River Front Work and Levee System, Ariz	Sept. 16	Construction of earthwork and structures for main outlet drain and Gila River pilot channel, and Gila River siphon to Colorado River.	Vinnell Corp., Alhambra, Calif	996,370
400C-149	Provo River, Utah	Sept. 21	Construction of Carlile and Diamond Bar-X dikes for Provo River channel revision.	Engineers and Constructors, Inc., Salt Lake City, Utah.	259,640

Major Construction and Materials for Which Bids Will Be Requested Through December 1960*

Project	Description of Work or Material
Central Utah, Utah	Constructing 10.5 miles of lined and unlined canal with bottom width varying from 18 feet to 4 feet, and appurtenant structures, Stanaker Service Canal near Vernal.
Central Valley, Calif	Constructing the 300,000-cubic-yard Lewiston earthfill dam, 90 feet high and 780 feet long, and powerplant. North of Lewiston.
Do	Constructing 7.75 miles of cast-in-place concrete pipelines, and constructing about 11.5 miles of open laterals having bottom widths varying from 12 feet to 6 feet. Madera Extensions near Madera.
Do	Constructing a pipe distribution system with 30 miles of pipe varying in sizes of from 4 to 30 inches, including 7 small pumping plants and 4 moss-screen structures, Stone Corral Pipe Dist. System near Visalia.
Collbran, Colo	Completing the construction of the Upper and Lower Molina Powerplants, and switchyards including the installation of Government-furnished turbines and plant equipment. About 40 miles east of Grant Junction.
Do	Furnishing and constructing 5 miles of 115-kv, wood-pole Upper Molina-Lower Molina transmission line with conductors and overhead ground wires.
Colorado River Storage, Utah.	Furnishing and constructing 158 miles of 138-kv and 115-kv wood-pole transmission line from Vernal, Utah to Rangely, Colo. and from Rangely to Oak Creek, Colo.
Do	Furnishing and constructing approximately 43 miles of 138-kv, Flaming Gorge-Vernal, Utah wood-pole transmission line.
Hammond, N. Mex	Construction of Hammond Diversion Dam, consisting of a rockfill overflow weir 350 feet long, and an 850 foot long dike section on San Juan River.
Lower Rio Grande Rehabilitation, Tex.	Rehabilitation of about 10 miles of "I" Lateral and constructing unreinforced concrete lining, Near Mercedes.
Middle Rio Grande, N. Mex.	Constructing about 2 miles of overlap drain and levees structures and about 2 miles of gravel slope protection. San Juan Feeder Canal near Belen.
Do	Constructing about 8.5 miles of channel rectification works, including clearing a 600-foot-wide floodway, and Albuquerque Unit 1 on the Rio Grande near Albuquerque.
MRB, Iowa	Furnishing and construction 218 miles of 161-kv, wood-pole transmission line with conductors and overhead ground wires. From Sioux City to Spencer, Iowa, and from Sioux City to Creston, Iowa.
MRB, Kansas	Earthwork and structures for about 4 miles of 12-foot bottom width earth-lined canal. Cedar Bluff Canal near Ellis.
MRB, Mont	Earthwork, structures, and surfacing for about 7.7 miles of roads including one 50-foot span timber bridge. Yellowtail Dam 35 miles southwest of Hardin.
MRB, Nebraska	Clearing trees and brush and removing buildings from about 3,500 acres, in the Sherman Reservoir area, Loup City.
Do	Constructing the 1,000,000-cubic-yard earthfill Merritt Dam, 120 feet high and 3,100 feet long, on the Snake River, about 25 miles southwest of Valentine.
MRB, N. Dak	Furnishing and stringing conductors and overhead ground wires on 84 miles of 230-kv, single-circuit, steel-tower transmission line. Between Jamestown and Fargo.
MRB, S. Dak	Constructing footings and furnishing and erecting 230-kv single-circuit steel towers for the approaches to the Oahe and Fort Randall Switchyards. Near Oahe and Fort Randall.
Do	Furnishing and stringing conductors and overhead ground wires for 57 miles of 230-kv, double-circuit, steel tower transmission line. From Fort Thompson to Oahe Dam.
Do	Furnishing and stringing second circuit conductors on 339 miles of 230-kv double-circuit, steel tower transmission lines. From Fort Thompson to Watertown; from Pickstown to Fort Thompson; and from Pickstown to Sioux Sioux City, Iowa.
Rogue River Basin, Oreg	Construction of about 9 miles of West Lateral Extension and appurtenant structures, near Medford.
Do	Rehabilitation of about 12.5 miles of unlined West Lateral and structures near Medford.

*Subject to change.

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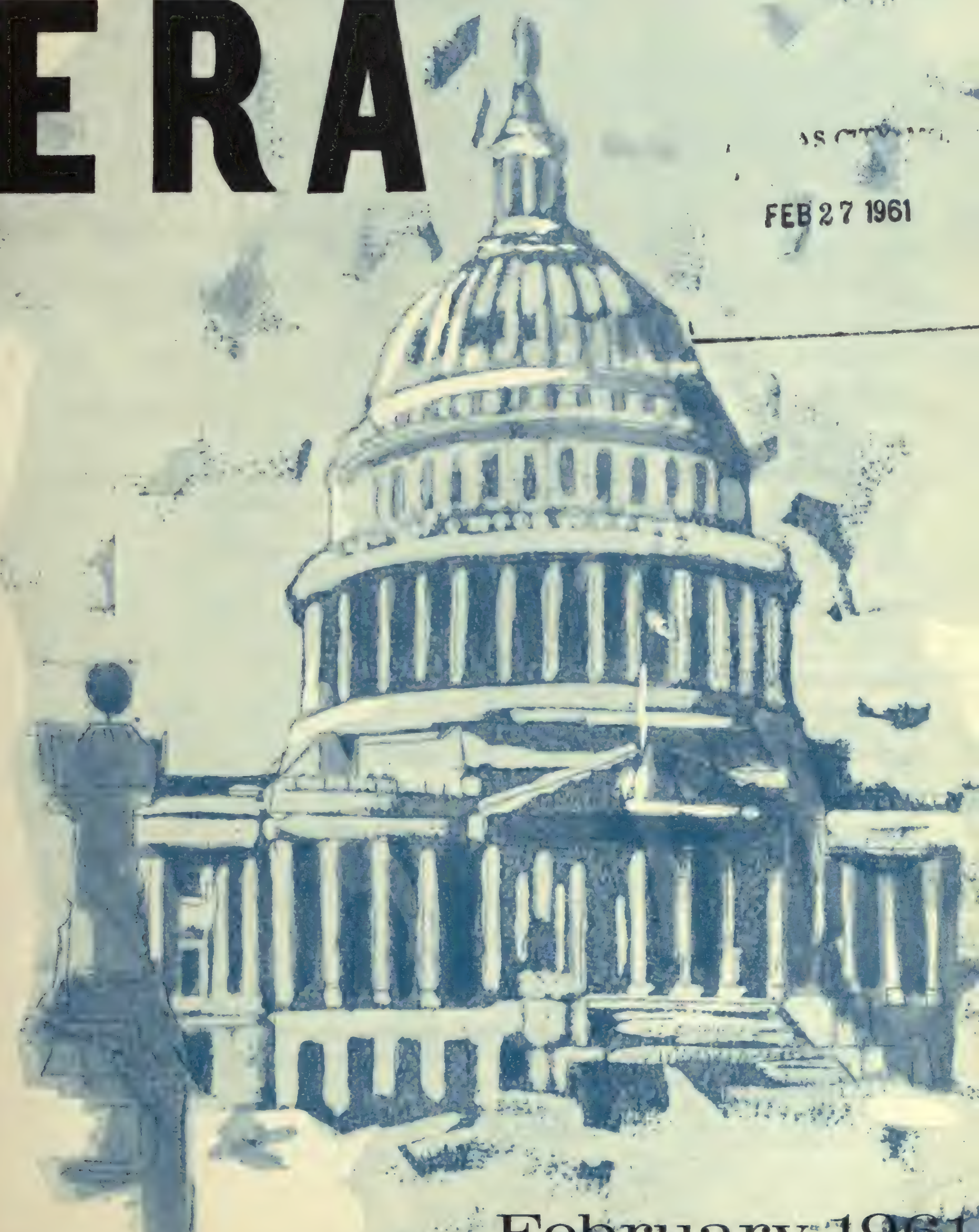
District Manager, Alaska District, P.O. Box 2567, Juneau, Alaska	Daryl L. Roberts

REGIONAL OFFICES

REGION 1: Harold T. Nelson, Regional Director, Box 937, Reclamation Building, Fairgrounds, Boise, Idaho.
REGION 2: Hugh P. Dugan, Regional Director, Box 2511, Fulton and Marconi Avenues, Sacramento 11, Calif.
REGION 3: A. B. West, Regional Director, Administration Building, Boulder City, Nev.
REGION 4: Frank M. Clinton, Regional Director, 32 Exchange Place, P.O. Box 360, Salt Lake City 10, Utah.
REGION 5: Leon W. Hill, Regional Director, P.O. Box 1609, Old Post Office Building, 7th and Taylor, Amarillo, Tex.
REGION 6: Bruce Johnson, Regional Director, 7th and Central, P.O. Box 2553, Billings, Mont.
REGION 7: John N. Spencer, Regional Director, Building 46, Denver Federal Center, Denver, Colo.

Reclamation ERA



February 1961

The Reclamation Era

FEBRUARY 1961 VOLUME 47, NO. 1

In this issue . . .

J. J. McCARTHY, Editor

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STEWART L. UDALL-NEW SECRETARY

The new Secretary of the Interior, Stewart L. Udall, brings to his job an understanding of the importance of natural resource development gained not only from his 6 years on the House Interior and Insular Affairs Committee but from the fact that his native Arizona presents a cross section of many Interior Department interests and responsibilities—reclamation, Indian affairs, national parks and monuments, and mineral resources. He has served on the Irrigation and Reclamation Subcommittee, as well as Mines and Mining, Indian Affairs, Territorial and Insular Affairs, and Public Lands.

In announcing the appointment of Mr. Udall, the first Cabinet member ever to come from Arizona, President Kennedy said: "I think we are particularly fortunate to have in the Department of the Interior the services of a dedicated, responsible, progressive American who has lived in the West, who recognizes the vital stake that the Nation has in the development of the resources of the United States . . . (These) are national resources and must be constantly surveyed in order to make sure that we are making maximum use of them."

Mr. Udall was first elected to the House of Representatives (84th Cong.) on November 2, 1954. His committee assignments included membership on the Joint Committee on Navajo-Hopi Indian Administration and the House Education and Labor Committee. Before going to Congress, he practiced law in Tucson.

Secretary Udall was born on January 31, 1920, in St. Johns, Ariz., a town founded in 1880 by his grandfather, David King Udall, a Mormon Church missionary who had migrated from Utah by covered wagon. The Secretary's father, the late Levi S. Udall, was chief justice of the Arizona Supreme Court.

Secretary Udall attended public schools in St. Johns and Eastern Arizona Junior College. He obtained his law degree in 1948 from the University of Arizona, where he played varsity basketball. He was a member of the first Arizona team to participate in the Madison Square Garden invitational. He plays tennis and likes to hike and do mountain climbing. He is also an avid reader.

During World War II, Secretary Udall served as an enlisted gunner on a B–24 with the Fifteenth Air Force in Italy.

In 1947, he was married to Miss Ermalee Webb of Mesa, Ariz. While in Washington, they make their home at 4551 Chain Bridge Road, McLean, Va., with their six children, Tom, 12; Scott, 11; Lynn, 10; Lori, 8; Denis, 4; and James, 1. Their other home is in Tucson. ###

N.R.A. re-elects officers

LaSELLE E. COLES

The National Reclamation Association, holding its annual convention at Bakersfield, Calif., reelected all officers headed by LaSelle E. Coles of Prineville, Oreg. Other officers, also reelected, are Hugh A. Shamberger, Carson City, Nev., first vice president; Harold Christy, Pueblo, Colo., second vice president; Lorin W. Markham, Spokane, Wash., treasurer; and William E. Welsh, secretary-manager with offices in Washington, D.C.

All of the officers except Mr. Welsh are also members of the board of directors representing their respective States. One new director was named at the convention, L. B. Caine, Logan, succeeding L. P. Harvey, Pleasant Grove, as Utah director. Other directors are: J. H. Moeur, Phoenix, Ariz.; B. L. Smith, San Francisco, Calif.; Alex Coleman, St. Anthony, Idaho; C. C. Green, Courtland, Kans.; D. P. Fabrick, Choteau, Mont.; C. Petrus Peterson, Lincoln, Nebr.; I. J. Coury, Farmington, N. Mex.; Milo W. Hoisveen, Bismarck, N. Dak.; Frank Rabb, Oklahoma City, Okla.; Arthur Svendby, Lemmon, S. Dak.; Guy C. Jackson, Jr., Anahuac, Tex.; and Earl T. Bower, Worland, Wyo.

The 1961 convention will be held in Billings, Mont., in October.

This was the first convention held in Bakersfield and provided the convention participants, more than 1,000 strong, the opportunity to visit some farm areas served by the Bureau of Reclamation's Central Valley Project.

Speakers at the convention generally stressed the importance of a continuing program and several, including a symposium on project justification, went rather thoroughly and favorably into a 100-year period in computing benefit-cost ratios.

Commissioner of Reclamation Floyd E. Dominy, in his annual report to the Association, warned of problems ahead over conflicting uses for water and the necessity of compromising these differences. He also called for uniform "ground rules" by all Federal agencies involved in water resource development to eliminate "shopping around" by local sponsors. # # #

COMMISSIONER REAPPOINTED

FLOYD E. DOMINY

Commissioner of Reclamation Floyd E. Dominy has been reappointed by President Kennedy and will continue to head the Bureau of Reclamation in the new Administration. Commissioner Dominy is a career Federal employee of more than 27 years and has been with the Bureau of Reclamation since 1946. He has been Commissioner since May 1, 1959.

ventura river project

One of the brighter examples of progress in water development through farsighted cooperation is the Ventura River project, situated in southwestern Ventura County, Calif., some 60 miles northwest of Los Angeles.

Several years ago the local residents, well aware of their increasing needs for municipal, industrial and irrigation water, entered wholeheartedly into an effort to conserve for beneficial use the water potentially available to them.

When the Ventura River Municipal Water District was voted into being in 1952, its formation was a tangible expression of purpose by the residents and property owners of the area. That purpose was to use all the means at their disposal to solve their water supply problems.

During the succeeding years, the local people, working with the Bureau of Reclamation, demonstrated time and again the kind of initiative and support that speeds up necessary preconstruction

LELAND G. BENNETT, General Manager and Chief Engineer, Ventura River Municipal Water District

Casitas Dam and portion of reservoir from west peninsula on Ventura River.

Excavation leaves gash in hillside for laying of Rincon Conveyance System main pipeline on Ventura River Project.

work. Now their faith in the project is paying off.

The District area encompasses most of the irrigable and habitable area of the Ventura River watershed plus a considerable area of coastal territory lying northwesterly of the Ventura River and extending to the southeasterly boundary of Santa Barbara County. The District includes that portion of the city of Ventura which comprised the total incorporated area when the District was formed, the city of Ojai, the unincorporated communities of Oak View and Meiners Oaks, and surrounding suburban and agricultural areas comprising the Ventura River, Santa Anna, Ajai, and Upper Ojai Valleys. (Of the 90,000 acres lying within its boundaries, only about 25 percent are considered irrigable or habitable.)

Because of the erratic rainfall pattern (minimum annual total under 5 inches and maximum over 40 inches) and the lack of surface storage works, the area has suffered chronic water shortages for years. Much of the usable area has remained in a relatively undeveloped state as lack of an adequate dependable water supply precluded extensive land use.

Studies by various engineers and agencies through the years had resulted in an accumulation of evidence that the local supply, if properly conserved, would provide an ample supply for all uses for many years. Earlier attempts to effect the development of required conservation facilities were largely fruitless, the one exception being construction of Matilija Dam by the Ventura County Flood Control District. Since its completion in 1947, this small storage facility (7,000 acre-feet) has provided a significant addition to the area's water supply.

The residents of this area had watched with keen interest the development of plans for and construction of the U.S. Bureau of Reclamation's Cachuma project facilities in neighboring Santa Barbara County. For this reason, it was not surprising that one of the earliest actions of the new District was to seek arrangements with the Bureau for a comprehensive investigation to determine present and future water needs, potentialities of local supplies for meeting such needs, and what works must be constructed to conserve and use the available local supply. Arrangements were completed in March 1953 for the Bureau to conduct such a feasibility study for the District on a match-fund basis.

Execution of this cooperative investigation contract was the initial step in a series of cooperative actions by means of which the Ventura River project was conceived and carried to completion in the short span of 6 years. It is believed that this is a record with respect to elapsed time for conception, design, and construction of a Federal reclamation project. The schedule was possible only because of the continuous cooperative efforts of all concerned.

Allotted space does not permit detailed enumeration of the many actions which helped expedite this project nor a listing of the many people responsible for the dovetailing of the various steps into the process which were so essential to the rapid execution of the whole program. However, no story of the project would be complete without at least a summary statement covering some of the more salient steps taken to shorten the design and construction period.

The feasibility investigation, initially expected to take 2 years, was completed in preliminary form within 1 year. Although not published as the Ventura River project feasibility report until December 1954, the preliminary report provided a working document for District consideration.

The studies verified that through construction of suitable storage, diversion, and distribution works, local supplies could be conserved and delivered in sufficient quantities to meet the supplemental water needs of the area for the next 50 years. It was estimated that the required system of works would cost $27,500,000. Results of the study were publicized through the press, and through public hearings it was determined that most of the District's residents favored earliest possible construction of the project, preferably as a Federal reclamation project.

Principal objection raised to seeking a Federal project was the expected lapse of time to reach the construction stage. It was estimated that under a normal schedule without extensive unexpected delays, about 4 years would be required to get construction under way. This would allow 1 year for processing the report through Interior and other Federal departments and to obtain approval of the state of California; 1 year additional to obtain congressional authorization; another to secure initial construction appropriations; and a fourth for final design and negotiation of the required repayment contract.

On the other hand, it was estimated that only 2 years would be required to vote District bonds and prepare final designs prerequisite to commencement of construction. A second look at the schedule for initiating a Federal project revealed that there were possibilities for performing certain steps concurrently rather than consecutively.

For example, it was determined that the Bureau could and would undertake required preconstruction work immediately if the work were financed by the District. With the assurance that such dovetailing of the work could substantially reduce the processing time, the District Board of Directors adopted a highly significant resolution on March 24, 1954, barely 1 year from inception of project investigations. Through this resolution, the District adopted the system recommended by the Bureau as that desired by it, requested the Bureau to process its report through the Department of the Interior with a view to its authorization as a Federal reclamation project, and asked that the Bureau furnish a form of agreement to cover prosecution of final design and other preconstruction work by the Bureau at District expense.

By July 1954, details of the preconstruction contract had been worked out and a contract executed under which, during the ensuing 2 years, the District would advance $720,000 to cover the cost of preconstruction work on the project. This assured that by the time project authorization was obtained and construction appropriations approved, plans and specifications for the project works would be ready for issuance. Furthermore, if Congress failed to authorize the project, such plans would be available for use for construction of the project by the District through the issuance of bonds.

As the report processing procedure and preconstruction activities advanced, another time reducing possibility occurred to the District officials. Why not negotiate the required repayment contract and secure voter approval in advance of congressional authorization? If this were done, the contract could be available for immediate execution by the parties if and when project authorization materialized. A mutually acceptable contract was developed and submitted to the District electorate at a special election on November 29, 1955. The voters overwhelmingly approved the contract by a vote of 30 to 1.

By this time, preconstruction work on the storage dam was nearing completion, and things

Workmen lay 39-inch pretensioned concrete cylinder pipe for Oak View Main, Ventura River Conveyance System.

Robles-Casitas Canal winds way through valley. Rectangular drop chute and siphon at left.

looked favorable for congressional approval early in 1956. If the project were authorized as expected, only lack of construction funds would prevent commencement of construction in 1956. Once again, through cooperative efforts of all concerned, funds for commencement of Ventura River project construction were included on a contingent basis in the Interior Department's appropriation request for fiscal year 1956–57. Everything worked as planned. The act to authorize the project was signed into law on March 1, 1956; the repayment contract was executed by the parties on March 7, 1956; specifications for construction of the storage dam were issued on May 16, 1956; and early in July 1956, after the appropriation bill had passed, a contract was awarded for construction of the dam.

The project works include some unusual features. Because of the extended periods of drought experienced by the area, the storage reservoir has a capacity of 250,000 acre-feet, nine times the safe annual yield of the project. This storage reservoir is located far down on Coyote Creek, a tributary of Ventura River, because the only suitable site for a storage facility of the required size that could be utilized without extensive right of way and pollution problems is located there.

The reservoir is formed by Casitas Dam which is a zoned earthfill dam 285 feet high and 2,000 feet long. As the main stem of Ventura River is the principal source of the project supply, water for storage, other than the natural flow of the Coyote Creek system, reaches the reservoir through the 5-mile-long Robles-Casitas Canal. This is a 500 cubic foot per second concrete-lined canal for most of its length but includes one 78-inch-diameter, reinforced-concrete-pipe siphon about 4,500 feet long. Water enters the diversion canal through headworks constructed as an integral part of Robles Diversion Dam, a low rockfill structure across Ventura River a short distance above the community of Meiners Oaks.

Water is distributed to all subareas of the District through a main conveyance system consisting of 34 miles of pressure pipeline which varies in size from 54 to 12 inches in diameter. Water enters this system directly from Casitas Dam through the Casitas outlet works, the intake structure for these works being unique in Bureau experience. It is a reinforced-concrete structure which rests on the sloping upstream face of the dam and encases a 48-inch steel outlet pipe which is fitted with nine hydraulically operated slide

Continued on p. 26

weed control

Improved controls have reduced water and incidental losses caused by weeds by nearly $16 million a year on Bureau of Reclamation and other irrigation systems in the 17 Western States, according to a joint report by the Bureau of Reclamation of the Department of the Interior and the Agricultural Research Service of the Department of Agriculture.

The report on the results of a 1957 survey of 47 Bureau and other irrigation systems, entitled "Weed Control in Western Irrigation and Drainage Systems," was recently issued as ARS publication 34–14.

Commissioner of Reclamation Floyd E. Dominy said that the results of the survey "show convincingly that the Bureau's weed-control program, as well as the efforts of the private irrigation system operators, is making good headway with better methods and the aid of the more effective chemical agents that have been developed within the past decade." The report also testifies to the effectiveness of our weed-control methods. He said, "The great economic expansion and population growth that lie ahead underscore the importance of our water conservation programs. Effective weed controls are a vital part of that continuing effort. We are making progress, but weeds still take a tremendous toll from our water resources—water we can ill afford to lose—and we must do everything possible to cut this problem down in size."

Projections based on surveys of 15 Bureau of Reclamation irrigation systems and 32 canal company systems estimated total water losses due to weeds of 1,966,068 acre-feet in 1957 in the 17 Western States. This is sufficient water to irrigate 330,000 to 780,000 acres of cropland, depending upon variations in growing seasons, evaporation losses and other factors. Losses of water costing users approximately $3,626,000

pays off

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Reclamation Engineering Lab employees in Denver study effects of herbicide on aquatic weeds.

were reported. The productive value of the lost water, figured at $20 per acre-foot, amounted to an estimated $39,321,000.

A team of four men—two each from the Bureau of Reclamation and the Agricultural Research Service—working in the Bureau's weed-control laboratory in Denver is responsible for much of the research now being done on aquatic weeds. The Agricultural Research Service also maintains four field stations at Laramie, Wyo.; Prosser, Wash.; Tempe, Ariz.; and Bozeman, Mont., where field tests are conducted under irrigation conditions on both waterweeds and ditchbank weeds. In addition, the Bureau cooperates with state colleges in weed-control research. The findings from this research are then put into practice, replacing more expensive and less effective methods of weed control.

The report's estimates of losses from weeds do not include those involving phreatophytes except those classified as woody plants occurring on ditchbanks. Losses from transpiration, flood damage, and sedimentation, caused by extensive acreages of phreatophytes around reservoirs, along streams, and on river flood plains, were not included in the report's loss estimates nor were related phreatophyte control costs. Weed damage to canals, structures, crops and farmland, estimated at $2 million, was included in the report's total loss estimates.

Total cost of the weed-control program during 1957 in the States in the Bureau's seven reclamation regions was estimated at $8,113,297.

"When it is recalled that estimated losses from aquatic weeds were nearly three times the losses from ditchbank weeds," the report states, "it becomes clear that improved methods of controlling aquatic weeds have not been adopted nearly so generally as have improved methods of controlling ditchbank weeds. For example, the use of aromatic solvents for control of pondweeds has been practiced extensively only in Regions 1 and 3, even though pondweeds are a serious problem in most of the other regions. The much higher cost of aromatic solvents in the smaller quantities used in most of the other regions may be an important factor in this difference." Region 1 comprises the Pacific Northwest and Region 3 the Pacific Southwest.

The report suggests that "the general lag in adoption of control methods for aquatic plants indicates a need for further improvement in methods of controlling these plants, especially rooted submersed waterweeds in larger canal."

Aquatic weed-control cost average $42.36 per mile of canal.

Ditchbank weed control costs averaged $21.45 per acre. Generally, the cost of control per acre was relatively low in areas where herbicide 2,4-D

Continued on p. 25

Weed burning on Yuma Project in Arizona clears ditch.

The Palo Verde Weir

Palo Verde Weir near Blythe, Calif., on the Colorado River, a rockfilled structure, was built to rescue the fertile Palo Verde Valley from drought and has won a niche in the area's history. Valley lands are an old alluvial flood plain, deposited by the Colorado River in past years as its channel meandered the confining hills.

The history of the valley is interwoven with the history of the Colorado River, on which it has always been dependent. The valley abuts the west bank of the river about 100 miles north of Yuma, Ariz. The western edge of the valley is formed by a mesa, low tableland, which parallels the river about 8 miles to the west. The mesa, and low hills on the north and south, pocket the valley against the river.

In the late seventies, Thomas Blythe, by virtue of the Swamp and Overflow Act, secured title to a block of land comprising roughly the northern third of the Palo Verde Valley. Blythe cultivated some land in the northern part of the valley for which water was first diverted in 1879 from the Colorado River by gravity. Agriculture of the valley was greatly stimulated when, in 1904, the Palo Verde Land & Water Co. purchased the land holdings. During 1905, most of this farming ceased because of a very destructive flood.

In 1923 the California State Legislature passed

a special act creating the Palo Verde Irrigation District. In 1925 the Irrigation District became the sole operating agency for the irrigation of the Palo Verde Valley.

The completion of Parker Dam in 1938, about 58 miles upstream from the Palo Verde Valley, was followed by degradation of the riverbed. By 1940 the river water surface had lowered such that diversion of the District's water supply was difficult. By 1942, diversion to the District could be effected only at such times as the river was carrying more water than required for downstream irrigation.

The annual uncontrolled floods of the Colorado River made agriculture of the valley a hazardous gamble until the completion of Hoover Dam in 1935. Since that time, farming in the valley has been less of a gamble and the farmers have prospered. From a few hundred acres in the 19th century, the irrigated area grew to about 40,700 acres by 1942 and decreased to about 39,600 acres by 1944.

In 1943 and 1944, the prospective loss of Palo Verde Valley crops would have had serious effects upon the war effort. To alleviate this problem temporarily, the First Deficiency Appropriation Act approved April 1, 1944, provided for the construction of the temporary weir.

The immediate purpose of the temporary weir was to raise the river level to such height as would provide satisfactory diversion of river water through the Palo Verde Irrigation District's intake. This required that the water surface be raised about 4 feet, or to elevation 286 feet above sea level.

When the First Deficiency Appropriation Act was approved, it was assumed that the weir would be located downstream from the existing intake structure. As the investigations progressed, however, it became evident that the most economical and safest location for the weir was about 900 feet upstream from the then existing intake structure. Location of the weir at this site required excavation of a diversion channel and the construction of a new intake structure.

Erection of an overhead cableway, for depositing rock on the riverbed along the site of the weir, started in June 1944, and was completed by the

This rockfilled structure rescued fertile valley on west bank of Colorado River.

end of the calendar year. The headtower and tailtower for the cableway were erected on the California and Arizona banks, respectively. The tailtower was a traveling, counterweighted tower, which was supported by railroad rails embedded in a concrete foundation. Movement of the tailtower along the rails was controlled from the control room within the base of the headtower.

A rock quarry was located and opened about 1,500 feet west of the river. A trial run of dumping rock in the river from the cableway started on January 12, 1945. Full scale rock dumping commenced a few days later. The rock was dumped from the cableway bucket in one layer progressively from bank to bank. Successive layers were similarly placed, so that the crest of the weir throughout its length was uniformly raised to its designed elevation. As placement of the rock progressed, the river water surface upstream from the weir gradually raised. By the end of April 1945, the river surface had raised to the required elevation and the weir was considered completed. At this time the elevation of the river surface, upstream and downstream from the weir, was 286.1 and 281.7 feet, respectively, above mean sea level, at a river discharge of 16,000 cubic feet per second.

At the request of the Palo Verde Irrigation District, Government forces also designed and constructed the new intake structure with funds advanced by the district, because the language of the appropriation act for the weir did not provide for the contingency of a new intake structure. Construction was started early in May 1945 and on June 24, 1945, the first water was diverted through the new diversion channel and intake. Gravity diversion, previously enjoyed by the Palo Verde Irrigation District, was restored.

The saga of the rock weir was not complete, however. River water, cascading over the downstream rock slope of the weir ate away the riverbed at the toe of the weir. Also, degradation of the riverbed downstream from the weir was similar to the degradation that takes place downstream from a dam. The initial 4 feet difference in water elevation upstream and downstream of the weir gradually increased. During the fall of 1945, the same year the weir was placed, a breach opened overnight. Additional breaches occurred in 1946. While these breaches were filled with rock, it was evident that the weir required major strengthening if it was to endure. Major strengthening was accomplished during 1947, but other breeches opened up in 1948, 1949, 1951, and 1952. The last failure, January 1952, was the most severe and, if this type of failure had occurred during the heavy irrigation season, large damages to growing crops would have been certain.

Survey crew checking level of Palo Verde Weir, which provided satisfactory diversion of river water.

It was not necessary to place any rock during calendar years 1954 and 1955. The following table shows the quantities of rock fill placed:

	Cubic yards placed on river banks	*Cubic yards placed in weir*
Original construction	1,500	40,000
Major strengthening, 1947	2,772	52,606
Maintenance:		
October, 1945		2,344
May to December 1946		16,734
February to March 1948		5,324
June to November 1949	1,328	35,658
March to April 1951		6,120
January to April 1952	1,696	24,056
December 1952		5,568
July and August 1953		3,440
Total	7,296	191,850

The story of the weir is about finished. The permanent solution of the Palo Verde Problem, resulting from an investigation by the Bureau of Reclamation and the Office of Indian Affairs, originally comprised four alternates, as follows:

(*a*) A pumping plant to lift river water into the existing canal system of the Palo Verde Irrigation District.

(*b*) A canal from Headgate Rock Dam along the east side of the river through the Colorado River Indian Reservation with a siphon under the river for delivery of river water into

the existing canal system of the Palo Verde Irrigation District. The canal also would serve Indian lands to the east of the river and, therefore, would be used jointly by Indian and Palo Verde interests.

(*c*) A permanent diversion dam at the Palo Verde Intake to deliver river water into the existing canal system of the Palo Verde Irrigation District at an elevation corresponding to the elevation of diversion maintained by the Palo Verde Weir.

(*d*) A canal from Headgate Rock Dam along the west side of the river to deliver river water into the existing canal system of the Palo Verde Irrigation District.

A comparison of the four alternate solutions for diverting river water into the Palo Verde Irrigation District's canal system at an elevation corresponding to diversions from the weir, reduced the alternates to the two most favorable, which were the pumping plant and the east side canal. A cost comparison of these two plans favored the pumping plant.

The Palo Verde people were reluctant to accept the pumping plant because of operating costs and because they had always enjoyed gravity diversion. As a result of a conference between Palo Verde and Department of Interior representatives a low level diversion dam to divert river water at an elevation of 4 feet below the elevation corresponding to diversions from the weir was adopted as a compromise solution to the problem. The Palo Verde people found that, by some modification of their canal system, the gravity diversion at the reduced elevation was satisfactory. As a result, Public Law 752 providing for the low diversion dam was approved on September 2, 1954.

This structure diverted Colorado River water for Palo Verde Irrigation District.

Now that a new structure is in operation, the old weir which served the valley so well, is in the realm of history.

TESTS OF WATER EVAPORATION CONTROL MADE ON ARIZONA PROJECT

A second major cooperative field tests of methods which seek to curtail heavy water losses from reservoir evaporation were made last summer in Arizona.

The tests were performed on Lake Sahuaro above Stewart Mountain Dam on the Salt River where an estimated 7 feet of the reservoir's level is lost annually by evaporation. The ultimate objective of this research is to develop practical methods to conserve the tremendous quantities of water lost in this manner for irrigation and other useful purposes.

Scientists and technicians of two Department of the Interior agencies—the Bureau of Reclamation and the United States Geological Survey—and the Salt River Project conducted the tests beginning in June and continuing through September. They used a harmless chemical film known to have no ill effects on animal or plant life and water quality for domestic use. It does not interefere with recreation uses.

The Bureau of Reclamation was responsible for the application and evaluation of the chemical film, only one molecule thick when applied, and is known as a monomolecular film, or monolayer. The Geological Survey determined the amount of water saved by the process while the Salt River Project furnished use of the reservoir and provided necessary facilitating services and equipment.

The Robert A. Taft Sanitary Engineering Center of the U.S. Public Health Service and the Arizona State Fish and Game Department observed the operations.

The chemical, a mixture of hexadecanol and octadecanol, was first applied to the surface of Lake Sahuaro last December to determine the behavior of small patches of the monolayer in wind and water currents. Similar behavior tests were also conducted last fall on Lake Mead above Hoover Dam on the Colorado River.

navajo dam

Eighteen short months after the marshaling of men and equipment at the Navajo Damsite in New Mexico, the San Juan River responded to man's control when its waters were diverted through an outlet-works tunnel. On January 4, 1960, the river began the change in character from an uncontrolled free-flowing stream to a controlled stream. Since January 4, the earth barrier on the old river channel has risen 200 feet in height and has expanded hourly in volume.

Working 20 hours a day, 5 days per week, the prime contractor, Morrison-Kaiser-F & S, will add an estimated 9 million cubic yards of embankment materials (earth, sand, gravel, and rock) to the dam during calendar year 1960. Reduced to daily and monthly rates, this means an average daily rate of approximately 35,000 cubic yards and an average monthly rate of 750,000 cubic yards.

Visualize huge earth-moving trucks being loaded by a 17-cubic yard dragline bucket, then speeding away to the dam with 30 to 50 tons of materials at 30 to 40 miles per hour. Repeat this operation over a 20-hour day, add a dozen hauling units, and you come up with a good day's work. Now add three such cycles working independently of each other, and the day's accomplishment is tremendous. Such is the operation at Navajo Dam.

***Note: Mr. Seery has subsequently been named construction engineer for the Curecanti (Colo.) Unit, Colorado River Storage project.**

by J. D. SEERY, Office Engineer, Navajo Storage Unit, Farmington, N. Mex.*

Conventional (foreground above) and self-propelled 4-drum sheeps foot rollers take part in dam embankment operations at Navajo Dam in New Mexico. At right, in concrete placing operations, bucket is mounted on carriage for use on steep spillway slope.

An average of 35,000 cubic yards of embankment material is hauled daily.

Benefiting by generally clear and sunny weather, sound safety practices, and good labor relationships, the construction of Navajo Dam is now about 18 percent ahead of schedule.

The picture is not complete, however, without mention of the use of the most modern construction equipment. One such piece of equipment is the self-propelled four-drum tamping roller which is used for compacting materials on the dam embankment. The basis of design of this unit is the modern concept of building a motor in a wheel. In this case the motor is electric and the wheel is the roller drum. Couple four roller drums together, add an internal-combustion engine driving an electric generator supplying electricity to motors in the drum, and you have the latest in tamping rollers.

Diesel-powered, self-loading and unloading scrapers with front and rear motors are not new to construction, but they are very modern. Eleven units are employed, each of 30-cubic yard load

capacity and with power to move the load at 35 to 40 miles per hour. This fleet contributes greatly to the progress being made in contruction of the huge earth dam.

The speediest piece of equipment on the job for transporting earth materials is a new type tractor-trailer truck. The unit is 9 feet wide and 60 feet long with a heaped capacity of 33 cubic yards and level capacity of 27 cubic yards. This truck and trailer unit is mounted on 18 wheels with 10 wheels driving, is powered by a 380-hoursepower diesel engine, and has the ability to travel under full load at 40 to 50 miles per hour. The trailer unit has the appearance of a large bin or hopper suspended between two heavy steel trusses. Naturally, this type of unit is employed on the longer hauls, moving materials a distance of approximately 3 miles.

Speed of loading and hauling to the embankment is not the complete story of the operations. Every load of material must be spread and compacted in place on the dam. Here, too, is a busy scene of coordinated activities.

The construction of reinforced-concrete control structures has kept pace with embankment activities. Efforts during 1960 have been concentrated on the spillway structure and more particularly on the chute section of the spillway where approximately 8,000 cubic yards of concrete were placed during 1960. In addition, 2,770 cubic yards of concrete were placed in the outlet-works tunnel.

It is appropirate to have a look at the impact of this huge construction job. The average number of on-site employees during 1960 was 510. This figure includes the employees of the prime contractor, the subcontractors, and the Federal Government. The earnings of the construction worker average $2.974 per hour with weekly employment of 45 hours. Thus, the weekly payroll of approximately $70,000 contributes to the regional and national economy.

Artist's conception of Navajo Dam, earth and rockfill structure 408 feet high.

The contractor's village, developed from scratch on a nearby sage-covered terrace, houses 200 employees or a total of about 800 inhabitants. Here you will find new house-trailers and automobiles, boats, green lawns, TV sets, and the milkman making his daily rounds. School buses transport 100 students from the Navajo camp to the Blanco and Bloomfield schools—13 miles and 22 miles, respectively, from the campsite. Newly developed 40-mile-long transmission lines bring electric energy to the dam and construction village, and natural gas is available from nearby feeder lines. The new post office serving the Navajo camp carries the name of Navajo Dam, New Mexico.

Not to be overlooked are the 300 or so commuting employees who live in the nearby communities of Aztec, Blanco, Bloomfield, and Farmington. Through their earnings, they contribute to a better San Juan Basin, and in a broader sense to the Nation.

The purchase of supplies and repair parts for servicing equipment (which originally cost the contractors about $4 million) soon fits into the realm of big business. Here even the tire bill comes high. Thirty thousand gallons of diesel fuel are used monthly. Repair parts come high and are purchased from everywhere; perhaps $100,000 this month from the west coast and a like amount next month from the Midwestern States. Cement, structural steel, reinforcement steel, and lumber arrive daily in truck load quantities.

The Bureau of Reclamation will purchase $1 million worth of gates, pipes, control equipment, and apparatus for installation in Navajo Dam, and the contractor will purchase an additional $2 million worth of materials. These will come from manufacturing centers located north, south, east, and west. The simple meaning is that industrial cities, such as Akron, Birmingham, San Francisco, Denver, and Dallas, contribute to the development of Navajo Dam and are benefited economically by its construction.

There is truth in the traditional concept that an earth dam can be constructed of materials at hand and without the importation of large quantities of

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managing subsoils exposed by land leveling

Many problems occur in developing land for gravity irrigation. One big problem is how to manage subsoils exposed during the land leveling operation. Most of the information on subsoil crop production shows that yields decrease because of the loss of surface soil. Usually, decreased yields are due to deficiencies of nitrogen, phosphorus and potassium, and sometimes minor elements. Poor physical conditions reduced the yields in some experiments.

Most of the soils in the Northern Great Plains in areas proposed for irrigation will require land leveling for gravity irrigation. Because of the irregular topography which is found in many fields, this operation will require deep cuts which will remove most of the surface soil.

Leveling of soils in desert regions usually causes fewer problems than the leveling of soils in the Northern Great Plains. The reason is that the textural and chemical differences between surface soil and subsoil are greater in the Northern Great Plains than in the desert. Moisture shortages in arid regions limit plant growth, causing the soils to be low in organic matter and nitrogen. Surface and subsoil texture tend to be similar in arid regions. Great Plains surface soils are higher in organic matter and nitrogen than soils found in the desert.

A laboratory study at Mandan, N. Dak., of soils sampled from Upham, N. Dak., showed that total and available nitrogen, and available phosphorus and zinc decreased with soil depth. About half of the available phosphorus in the top 3 feet of soil was contained in the surface 8 inches. When 6 inches of soil was cut from an acre, about 3,600 pounds of total nitrogen were removed. If we assume that soil nitrogen becomes available at a rate of 2 percent per year, this represents a loss of about 70 pounds of available nitrogen per acre

by CARL W. CARLSON and DAVID L. GRUNES, Soil Scientists, U.S. Department of Agriculture, Mandan, N. Dak.

Growth response of barley to nitrogen fertilizer at different soil depths and mixtures of depths.

per year. Two-thirds of the available zinc found in the top 4 feet of soil were in the top foot.

In a greenhouse study, yields of barley grown in both surface and subsoil were higher when nitrogen and phosphorus were added together than when either was added alone. Maximum yields on subsoils were obtained when nitrogen, phosphorus, potassium, and minor elements were applied.

When surface soil was mixed with subsoil, yields for all fertilizer treatments became larger as the percent of surface soil in the mixture increased. This increase was largely due to the phosphorus available in the surface soil. At least 25 percent surface soil in the mixture was required to obtain appreciable benefit.

At Upham, N. Dak., field studies were conducted on an area that had not been disturbed and on an area which had 1 foot of surface soil removed during land leveling (cut area). The same fertilizer treatments were used on both areas. The first year after the land was leveled, nonfertilized plots on the cut area yielded 3 tons of corn silage per acre

Corn plant on right, from undisturbed area; plant on left, from cut area. *(Photos furnished by the authors)*

(75 percent moisture) while on the undisturbed area the yield was 12 tons. Grain yields were 5 bushels per acre on the cut area as compared to 46 bushels on the undisturbed area.

Silage and grain yields were about the same for both areas with the application of 180 pounds nitrogen, 44 pounds phosphorus, and 15 pounds zinc per acre. Nitrogen and phosphorus applied alone on the cut area did not give yields as high as when both elements were applied together. Where surface soil was removed, manure at rates of 20 and 40 tons per acre increased yields, but not as much as treatments receiving nitrogen, phosphorus, and zinc fertilizer.

On the cut area, zinc applied at a rate of 15 pounds per acre increased corn silage and grain yields on all treatments except those receiving manure. There was sufficient zinc in 20 tons of manure to take care of the needs of the corn plant. Grain yields were increased more than silage yields by the application of zinc. Fifteen pounds of zinc per acre were sufficient for at least 3 years.

A study of the residual effects of nitrogen, phosphorus, and manure showed that nitrogen had to be applied each year. If high rates were used, phosphorus needed to be applied only once every 3 years. Benefits from manure were still evident 3 years after application.

In some areas, the problem of iron chlorosis on high-lime subsoils exposed by leveling is critical. There are at present no adequate controls for iron chlorosis except resistant crops or iron-containing sprays that often are not too effective.

There is little doubt that the addition of adequate amounts of nitrogen, phosphorus, and manure to exposed subsoils can increase yields so that they will generally equal those obtained on fertilized topsoil. For maximum production, a cut area generally needs about twice as much nitrogen and phosphorus as undisturbed soil. If alfalfa is grown on a cut area, the amount of nitrogen needed by succeeding crops will be reduced. A considerable quantity of nitrogen was fixed by growing 2 years of alfalfa on a cut area at Upham, N. Dak. It was necessary to apply a heavy application of phosphorus at the time the alfalfa was seeded for maximum nitrogen fixation.

Mixing some surface soil with the subsoil during the land leveling operation is advised. This procedure may markedly reduce the need for additions of phosphorus fertilizer. Continued on p. 27

cobb lake navy

The Cobb Lake Boat and Ski Club is pioneering a new field in the annals of Reclamation history. Within only a few weeks after the contractor for the Bureau of Reclamation effected closure of Fort Cobb Dam near Fort Cobb and Anadarko, the club, incorporated under the State laws of Oklahoma, obtained a concession from the Board of Directors of the Fort Cobb Reservoir Master Conservancy District to manage the recreational aspects of the reservoir on an interim basis, pending final completion of the Fort Cobb Division of the Washita Basin project. Closure of the dam was effected on March 30, 1959, and the persistent little Cobb Creek, augmented by rather heavy rains, by July had created a reservoir some 4 miles long, three-fourths mile wide, up to 25 feet deep, with roughly 15 miles of shoreline. By this past summer the reservoir was approximately 7 miles long, 1½ miles wide, and a maximum depth of 52 feet, with a shoreline in excess of 32 miles. About 42,500 acre-feet of water was impounded.

On its own volition, this club, comprised primarily of residents of local Caddo County, performed an outstanding public service in patroling the lake to avoid accidents, minimize hazards, and concurrently enhance water sports, on a nonprofit basis. Revenues collected by the club from over 100 members through dues of $25 each, and through the sale of permits and licenses, are used in the enforcement of safety provisions, and for the construction of sanitary facilities, installation of electric power service, and in general to improve and expand shore facilities before more permanent works were constructed. A deputized part-time lake patrolman was hired by the club for duty during weekends and holidays to enforce safety regulations.

Better known as the Fort Cobb Navy, with Ernest Simpson, a resident of the town of Fort Cobb and president of the Cobb Lake Boat Club, as its admiral, the fleet, joined by other enthusiastic western Oklahoma citizens, enjoyed witnessing in excess of 120 craft afloat on warm days during the first summer, which reflected the dynamic interest of this section of the State in water sports. The majority of the boats are of 14- to 16-foot lengths, propelled by 35- to 75-horsepower outboard motors. Numerous sportsmen's clubs are organized around the recreational opportunities of the many lakes in Oklahoma, but this club, pertaining specifically to Fort Cobb Lake, is unique because of its efforts to generate interest, enforce safety measures, and develop recreational activities in this Bureau of Reclamation reservoir without outside help from either the State or Federal Government. The National Park Service prepared plans for rather extensive ultimate developments, and the Bureau Project Office prepared the design and specifications for the initial stage of the development referred to as the basic facilities now under construction. The Bureau has now essentially completed these facilities.

The entire Fort Cobb Dam was built in some 18 months by the Cook & Hyde Construction Co. of Jackson, Miss., on a fast-moving scale. Acquisition of right-of-way, along with clearing the reser-

by IDA MAE TOMLINSON, Secretary, Washita Basin Project, Oklahoma

Boat launching area at Fort Cobb Reservoir is a busy place for boaters enjoying Sunday afternoon on the lake.

voir area, was systematically synchronized into a well-planned operation. In approximately 2 years the Project Office was opened in Anadarko, the first parcel of land was purchased, and a dam built ahead of schedule and at a cost below estimates or contract bid price.

When the lake first started to form it was considered advisable, for safety reasons, to close the entire area to all water sports. This policy met with such strenuous opposition from the local sports enthusiasts that the Bureau of Reclamation and the Conservancy District felt justified in allowing the recreational aspects of the lake to be developed in advance of the scheduled construction of recreational features. To accomplish this, the Bureau and the District entered into an interim agreement whereby the District assumed the responsibility of managing, through subordinate concession arrangements, the recreational activities of Fort Cobb Lake until more permanent management could be established, at the District or State level. Under its contract with the Bureau the District is responsible for all operation and maintenance of recreational facilities. The District subsequently granted the sports concession to the Cobb Lake Boat and Ski Club. The club feels relatively free from serious liability since under its corporate charter the club cannot be sued for more than the amount of money in its treasury.

The State Department of Wildlife Conservation stocked the lake immediately after closure of the dam with 100,000 tiny bass and 55,000 crappie, and closed the lake to fishing. It is expected that within 2 years from the time they were put in the lake these fish will be large enough to permit fishing in the upstream half of the reservoir, which has been reserved for wildlife activities and which will undoubtedly be covered with slower moving fishing craft enjoying that recreational aspect of the lake.

The Washita Basin project was well supported by the people during the planning stage, and this support has accelerated and expanded, and has continued to increase during the past year. The signing of the repayment contract by the Conservancy District is now being heralded as a sound step, and the development of this Division is causing other individuals and organizations on other projects being planned by the Bureau to look forward to and to support the development of similar projects throughout the State of Oklahoma. Construction of the Fort Cobb Dam and

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milestone for terra bella

April 16, 1961, will be a milestone in the water development progress of the Terra Bella Irrigation District, a district receiving water from the Central Valley project in California.

It will also be a milestone in the relatively new Public Law 130 program which allows loans to individual districts to construct their own distribution systems on Bureau of Reclamation projects, in lieu of construction by the Bureau.

On April 16 of last year the dedication of the Bradford Station, a key unit of the system located about 5 miles south of Porterville, signified the completion of the first distribution system constructed under the Public Law 130 loan program.

The Terra Bella Irrigation District, which is located in Tulare County, Calif., was organized on August 7, 1915, and in November 1916, a bond issue for $1 million was voted to build a distribution system. Through the years it became evident that the water supply would not be sufficient to irrigate the entire 12,000 acres within the district. This, coupled with adverse economic conditions, affected the stability of the district severely and it was actually "nip and tuck" as to whether the district would survive.

The district weathered the 30's and was among the early enthusiasts for the Central Valley project which was authorized for Federal construction by the Bureau of Reclamation in 1935. The principal features authorized at that time included Shasta Dam on the Sacramento River; Tracy Pumping Plant and the Delta-Mendota Canal, required to provide a supplemental water supply in the Delta-Mendota Canal service area and to replace San Joaquin River water rights; Friant Dam on the San Joaquin River, and Madera and Friant-Kern Canals required to distribute project water to water user districts in the east side of the

by J. M. INGLES, Region 2, Fresno, Calif.

This is the new office and operational control building for Terra Bella Irrigation District.

These are Bradford Station pumping units for the Terra Bella distribution system.

San Joaquin Valley from Chowchilla to Bakersfield.

Construction was sufficiently completed to enable delivery of project water in the initial reaches of the Friant-Kern Canal in 1949. In 1950 Terra Bella Irrigation District received its first water from the project pursuant to a temporary contract. In September 1950 a long-term water service contract was executed with the United States for a maximum delivery of 29,000 acre-feet of water annually from the Friant-Kern Canal of the Central Valley project. This gave a tremendous boost to the district; however, in order to use the entire newly acquired water supply and to serve the entire district area, an enlarged distribution system was required. Public Law 130 seemed to be an ideal answer for the district.

Central Valley's Friant-Kern Canal is a source of water supply for Terra Bella Irrigation District.

In February 1958, the form of a proposed distribution system loan repayment contract was approved by the Secretary of the Interior. Diligent effort by representatives of the district hastened the approval of the contract by the California Districts Securities Commission, a necessary step under California law. On April 22, 1958, the electors of Terra Bella Irrigation District voted overwhelmingly "yes" on the measure—385 to 15. The contract was executed less than a week later—April 28, 1958. Actual construction on the system, which began in November 1958, progressed rapidly and the dedication of the Bradford Station at the turnout of Friant-Kern Canal completed the partnership arrangement. Thus, with the use of \$2,100,000 provided by the contract, of which \$1,900,000 is the loan to the district under Public Law 130, construction of the main conveyance has been completed and is now being used by the district to divert and transport Central Valley project water. Additional facilities, principally sublaterals, meters, etc., required for water service to new lands are currently being constructed by the district and financed from its own resources. The estimated cost of the total construction work contemplated by the district is \$3,570,000—\$1,900,000 borrowed from the United States and \$1,670,000 to be financed by the district from other sources.

H. P. Dugan, regional director, region 2, in a letter to the district congratulated the district "on the expeditious manner in which construction has been accomplished and the quality of the constructed facilities. We are certain the facilities will serve you well for many years. * * * We wish to express our appreciation for the usual pleasant and businesslike association with your district in connection with this contract and we are looking forward to a continuation of this relationship."

This is another example of cooperation between the Bureau and local districts providing worthwhile water developments. The intent and purpose of construction of a distribution system under Public Law 130 has been carried out to the satisfaction of the district and the Bureau. At the present time Public Law 130 contracts have also been executed with the Solano Irrigation District, Saucelito Irrigation District, Chowchilla Water District, and negotiations are underway with five additional districts, all of which are in the Central Valley of California.

# # #

CAMERA-EYE VIEW OF WATER DEVELOPMENT

Water is a key, a bridge, or a producer of miracles, depending on the poetic license of a title writer. But it all adds up to the same thing—water is essential to life, and often man's efforts to control the available supply and put it to use approach the awesome. The spirit of this stupendous effort has been captured in two of the latest films involving a Bureau of Reclamation project—the Colorado River Storage project in general and Glen Canyon Dam, on the Colorado River in Arizona, in particular.

"Key to the Future," a 16-mm sound motion picture in color which runs for 32 minutes, is a Bureau of Reclamation production that tells the story of the CRSP, where four major storage units—Glen Canyon, Flaming Gorge in Utah, Curecanti in Colorado, and Navajo in New Mexico—are under construction. Among the sequences in the film are the spectacular snow-capped Rocky Mountains that feed the area's major streams, the gorges where men and heavy machinery are building storage dams, and the potential wealth of the upper basin in the form of high-value crop production and minerals such as oil, natural gas, coal and uranium whose development awaits the impetus of adequate water and power supplies. This is a valuable complement to the Bureau's picture of Glen Canyon Dam construction, "Canyon Conquest."

"Bridge to the Future" is a 16-mm sound motion picture in color which was produced by International Harvester Co. It concentrates on Glen Canyon Dam and is an especially good construction picture, although the sequences are by no means confined to construction. It is available through International Harvester Co.'s Consumer Relations Department, 180 North Michigan Avenue, Chicago, Ill.

"The Miracle of Water" is another Bureau of Reclamation production—a filmstrip in color which covers briefly the history of the Bureau, the urgency of resource development, and the dams, distribution systems and powerplants constructed in that development. Pictures include world-famous Grand Coulee Dam on the Columbia River and Hoover Dam on the Colorado. A booklet prepared by the Bureau for use with the filmstrip is also available separately. It includes the 53 pictures in the filmstrip and a brief narrative with each picture.

"Key to the Future," as well as other Bureau movies, and the filmstrip are available for use by schools and other organizations interested in conservation. The only expense to the borrower is return postage. Requests should be addressed to U.S. Department of the Interior, Bureau of Reclamation (Attn. 915), Washington 25, D.C.

# # #

NEW CONSTRUCTION ENGINEERS

Personnel appointments of the past few months included construction engineers on two of the Bureau's new multipurpose dam projects to be undertaken this fiscal year.

They are Roscoe Granger, construction engineer, Yellowtail Unit, Missouri River Basin project, and James D. Seery, construction engineer, Curecanti Unit, Colorado River Storage project. Mr. Granger has been assistant project engineer for the Flaming Gorge Dam, Utah, and Mr. Seery has been chief of the engineering division on another CRSP unit, Navajo Dam, N. Mex. Initial headquarters for Curecanti are at Gunnison, Colo.; for Yellowtail, temporarily at Hardin,

# # #

Name of Rimrock Lake, Washington State, Is Now Official

The name "Rimrock Lake" has been approved by the Board on Geographic Names for the reservoir created by Tieton Dam on Tieton River, a tributary of the Yakima River, in Washington State, the Department of the Interior announced recently.

The 8-mile-long reservoir in Snoqualmie National Forest, about 30 miles west of Yakima, has long been known as Rimrock Lake locally and the name is well accepted throughout the Yakima Valley. The name, "Rimrock Lake," was suggested by the Forest Service which administers the lake for recreation purposes.

Rimrock Lake is part of the Tieton Division of the Bureau of Reclamation's Yakima project. The project was one of the earliest to receive irrigation water from reclamation development, first water being delivered on the Tieton unit in 1910. #

BOOKS

GROUND WATER HYDROLOGY

by David K. Todd

JOHN WILEY & SONS, INC., NEW YORK

This book meets the present demand for a unified, comprehensive account of the fundamentals and recent methods and problems encountered in the field of ground water hydrology. In view of expanding population rates, increased industrialization, and greater individual use of water, the author reports on the important future role of ground water as a major water supply source in the United States. Problems dealt with include locating a ground water supply, constructing a well, and determining how much water it will yield; determining the amount of water that can be pumped from wells located near each other or near streams; dangers of pollution of ground water, whether it be from sewage, brines, industrial wastes, or from nuclear powerplants; and control of sea water in wells near the coast.

PRINCIPLES OF PLANT BREEDING

by R. W. Allard

JOHN WILEY & SONS, INC. NEW YORK

Principles of Plant Breeding is based on the idea that there is a basic unity to the methods of breeding self-pollinated species on the one hand and cross-pollinated species on the other and that this unity is more important than the differences in methods used among crops within the two groups.

This approach brings to the forefront the similarities of procedures appropriate to the improvement of various crop plants. At the same time, it places in proper perspective differences in reproductive biologies, cultural practices, and economic requirements of cultivated plants.

Plant breeding practices are included as an integral part of the discussion of principles. Examples are drawn from a wide variety of field forage, fiber, and vegetable crops.

HYDROLOGY

(Second Edition)

by Chester O. Wisler and Ernest F. Brater

JOHN WILEY & SONS, INC., NEW YORK

The second edition, extensively revised, presents a method for the determination of the magnitude of floods that may be expected to occur with specified rare frequencies on any given stream. Two entirely new chapters have been added. One deals with the hydrology of semiarid basins. The second new chapter treats the effects of snow upon the hydrology of an area. Field problems tackled in the book include determination of spillway and bridge discharge capacities; methods of flood reduction; water conservation practices; evaluation of potential waterpower on a river; and evaluation of amount of water available for water supply or waste disposal on a river.

TUCUMCARI COMBINATION MOWER

An unusually wet month in the summer caused a very heavy growth of weeds on the canal and lateral rights-of-way of the Tucumcari Project in New Mexico, as well as in the water prisms, since the ditches were empty much of the month. In order to use his mower tractors and operators in the most efficient manner, Project Manager, Sanford Caudill, put a 7-foot sickle cutter bar on the side of one tractor equipped already with a three-rotor, 8-foot cut, rotary mower mounted on the rear. This made it possible for the one machine to cut a 15-foot swath, clearing the operating road and one bank of a lateral in a single operation.

The side-mounted sickle cutter bar is driven by a hydraulic motor while the rotary mower is driven from the tractor power take-off. Both the rotary mower and the hydraulically driven sickle mower are available commercially. The price of the hydraulic mower is about $900. Anyone interested in obtaining equipment of this type may obtain the name of the supplier from Mr. Sanford Caudill, Manager, Arch Hurley Conservancy District, Tucumcari, N. Mex.

EXTENDING THE LIFE OF WOOD POSTS

The Government and the operators of irrigation projects are extensive users of wood posts for guard posts, guardrail posts, and fences. Quite often treated posts are not conveniently available, are not desirable because of painting requirements above ground, and are too expensive. L. E. Thompson, Canals Branch, Division of Design, Bureau of Reclamation, Denver, Colo., suggests that a simple on-the-job method for providing long post life can be accomplished by treating the soil used for backfill about the post with a wood preservative or soil disinfectant.

Post ends should be dipped in the preservative or sterilant prior to embedment. The disinfectant may be mixed with the soil prior to back-filling or poured onto the soil as the backfill is placed. The use of an oil preservative is advisable for shedding the water away from backfill mounded about the post. Backfill should be a mixture of clay, sand, and gravel to prevent heaving due to frost action, and to provide for a dense backfill free from shrinkage cracks. Following the post erection, the upper part may be coated as required.

Dense growth of aquatic weeds in experimental irrigation lateral at Reclamation's Denver Lab is examined by ARS plant physiologist.

Weed Control

Continued from p. 8

can be used extensively. In regions where 2,4-D must be used sparingly, such as in cotton or other sensitive crop production, more expensive chemicals or methods were used with resultant higher weed-control costs.

Methods of controlling ditchbank weeds included hand-cutting, mowing, burning, and spraying with different kinds of equipment.

Sixty-five percent of the mileage of the channels of the 47 systems, which provided the basic data for the weed-control report, was infested with aquatic weeds. Submerged water-weeds were a problem in 33 percent, on the average, of the mileage of canal, laterals, and drains. Infestation was slightly greater in laterals than in canals or drains. Algae were a problem in 25 percent of the canals, 11 percent of the laterals, and 18 percent of the drains. Emergent species, chiefly cattails, were a serious problem in the drains with slower moving water, less serious in laterals, and insignificant in the large canals.

Ditchbank weed infestations reported averaged 74 percent of ditchbank acreage, based on the following important weed growths: broadleaved perennials, 7 percent; perennial grasses, 16 percent; woody plants, 21 percent; and annuals, 30 percent. # # #

Navajo Dam

Continued from p. 16

products which we generally consider as being manufactured or processed. At the Navajo damsite, the relative expenditure for manufactured products is modest when compared to the overall project costs. Consider, however, that when completed, the dam will be, in itself, a manufactured product. Thus, the purchase of tools for the job and of power to drive the tools and the wages to men who operate, control and repair the tools constitute the important contribution both to the regional and to the national economy. # # #

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Bureau of Reclamation, Floyd E. Dominy, Commissioner

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Ventura River Project

Continued from p. 6

gates at uniform intervals between minimum and maximum reservoir water levels.

The outlet pipe connects to a 1,800-foot-long outlet tunnel bored through the left abutment of the dam. The outlet tunnel is a 7-foot-diameter circular section for about one-half of its length, the circular section terminating at a main valve chamber. From this point, the tunnel is an 8-foot horseshoe section, and the water flows through a 51-inch steel pipe. A catwalk is provided alongside the pipe to permit access to the main valve chamber. Each outlet gate is fitted with a semicylindrical screen which can be removed and taken to a washrack above high water through the operation of an ingenious system of tracks, cables, and pickup carriage. The hydraulic slide gates are operated by means of controls installed in a control house at the top of the dam.

Because much of the service area lies at a higher elevation than the storage reservoir, the main conveyance system includes five pumping stations, the largest of which has an ultimate capacity of 4,800 horsepower. For peaking and emergency storage, the system includes five steel tank balancing reservoirs with capacities ranging from 1,000,000 to 6,500,000 gallons. Disinfection of the water by dual chlorination is accomplished through the operation of five chlorination stations which have been provided. To extend the conveyance system farther into certain subareas of the District, the District is constructing some 15 miles of main extensions. It is also financing and constructing lateral distribution facilities in several areas of the District. Cost of these works, expected to involve about 25 miles of small diameter pipeline (4- to 12-inch), will eventually be repaid to the District by the property owners benefited by their construction.

Lush Ojai Valley, as seen from observation point on Highway 150, benefits from Ventura River Project.

Robles-Casitas Canal, from right side, showing lined prism and deep cut excavation.

The Ventura River project was placed in partial operation in November 1958. Bureau construction forces operated the diversion and storage works through the winter of 1958–59, while the District operated completed portions of the main conveyance system in conjunction with its operation of Matilija facilities which are interconnected with project facilities. On October 1, 1959, the entire project works were turned over to the District for operation and maintenance. The first two seasons of operation have yielded a disappointingly small amount of storage. However, the 8,000 acre-feet, more or less, which have been stored in Casitas Reservoir to date, together with the safe yield of Matilija, have made it possible to meet all demands for supplemental water.

While much more water is needed to realize the full recreational potential of the lake and the adjacent areas, facilities now available are used by many people from all areas of southern California. Activities are limited to boating, camping, and picnicking at the present time. However, the lake has been planted to several species of warm-water fish which reportedly are doing well, and it is expected that it will be open to fishing about April 1, 1961. # # #

* * *

There's a line in the ocean which by crossing you can loose a day—There's a line on the highway where you can do even worse.

Reclamation Safety Record

Cobb Lake Navy

Continued from p. 20

Reservoir was completed in October 1959, and its sister unit, the Foss Dam and Reservoir, being constructed near Clinton, Okla., is approximately 70 percent complete, and should be completed early in 1961. The impact of the completion of the Fort Cobb Dam and Reservoir, with the resultant benefits, is only beginning to be realized in recreational and business expansion throughout the area. Prior to the opening of the summer sporting season of 1960, the State recognized the significance of the recreation potential on the Fort Cobb Reservoir, and assigned a State patrolboat and officer to the reservoir to enforce safety regulations and eliminate some of the more hazardous and reckless speedboat activities. On last Memorial Day over 325 craft were afloat on the lake simultaneously.

Leon W. Hill, Director of the Bureau's Region 5, was highly complimentary to the Board of Directors of the District and the club, stating: "The District and the Cobb Lake Boat and Ski Club are to be congratulated for their foresight and commended for their action in accelerating recreational activities on this unit of the Washita Basin project." Under the direction of President Simpson, the Cobb Lake Boat and Ski Club intends to continue its work as long as the organization can be of benefit to the reservoir recreational activities. Recently Mr. Simpson was commissioned honorary admiral, staff of the Governor of Oklahoma, by Governor J. Howard Edmondson, for his fine work on the Fort Cobb Reservoir.

# # #

Fort Cobb Reservoir provides fun for all ages. Here small boy has his fling at water skiing.

SUGAR BEETS

Production of sugar beets in 1960 indicated a per-acre yield of 17.7 tons, 1.7 tons above average.

# # #

Foreground: Cut area with plants suffering from nitrogen, phosphorus and zinc deficiency. Background: Undisturbed.

Managing Subsoils

Continued from p. 18

Deficiencies of nitrogen can generally be predicted. Soil tests can reliably predict the probability of deficiencies of phosphorus and potassium. A soil test has been developed for zinc, but at present we cannot place too much reliance on soil tests for other micronutrients.

Physical problems can be created by land leveling. The consequence of reduced surface soil depth and water holding capacity should not be overlooked when deciding which areas should be leveled. Subsoils are frequently of finer texture than surface soil and after cutting for land leveling, it may be a clay that has to be managed rather than the original loam. Generally, the physical problems are aggravated by operating heavy earthmoving equipment when the soil is wet. Such operation should be avoided whenever possible.

In the Northern Great Plains, a cut area is invariably less fertile than a corresponding undisturbed area and, therefore, land leveling has been delayed in some instances. The research at Mandan has shown that the use of nitrogen, phosphorus, zinc, and manure will raise yields on subsoils exposed during land leveling operations. These findings should encourage the development of efficient irrigation systems in this area.

# # #

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5374	Weber Basin, Utah	Oct. 19	Construction of earthwork, pipe lines, and structures for pipe line laterals, West Farmington lateral system.	Elden H. Knudson Construction Co., Ogden, Utah.	334,001
DC-5387	Lower Rio Grande Rehabilitation, Texas.	Oct. 7	Clearing, and construction of earthwork, concrete lining, and structures for rehabilitation of F lateral system.	E. and M. Bohuskey Construction Co., Harlingen, Texas.	925,354
DC-5389	Klamath, Ore.-Calif.	Oct. 5	Construction of earthwork and structures for laterals and drains, Sump 3, Contract Unit 1.	M. J. Coleman and M. J. Coleman, Inc., Paradise, Calif.	247,504
DC-5391	Missouri River Basin, Nebr.	Oct. 10	Construction of earthwork and structures for Sherman Feeder canal, including tunnel, Sta. 656+48 to 1033+74.95.	Bushman Construction Co., St. Joseph, Mo.	1,682,722
DC-5392	Washita Basin, Okla.	Oct. 28	Furnishing and erecting one 1,900,000-gallon, one 357,000-gallon, and one 285,000-gallon steel water tanks for Foss aqueduct.	The Bering Co., Tank Division, Dallas, Texas.	180,394
DC-5393	Colorado River Storage, Colo.-N. Mex.	Oct. 24	Construction of earthwork and structures for relocation of Denver and Rio Grande Western railroad and county roads.	Colorado Constructors, Inc., Denver, Colo.	916,791
DC-5395	Missouri River Basin, Mont.	Oct. 14	Construction of roadway and structures for relocation of 15.2 miles of Union Pacific railroad.	Cherf Brothers, Inc., Sandkay Contractors, Inc., and Sime Construction Co., Ephrata, Wash.	1,395,336
DC-5400	Chief Joseph Dam, Wash.	Nov. 25	Construction of River and Booster pumping plants, discharge line, and a 2,000,000-gallon reservoir, utilizing steel pipe for the discharge line, Schedule 1.	Jensen-Rasmussen and Co. and B-E-C-K Corp., Sunnyside, Wash.	1,104,087
DS-5404	Central Valley, Calif.	Dec. 6	Furnishing and installing two 74,444-kva generators for Clear Creek powerplant.	General Electric Co., Denver Colo.	1,581,284
DC-5406	Middle Rio Grande, N. Mex.	Nov. 18	Construction of Socorro main canal north, headworks modification and flume.	Frank D. Shufflebarger, Albuquerque, N. Mex..	105,339
DC-5414	Washita Basin, Okla.	Nov. 30	Construction of earthwork, structures, concrete pipe, and concrete reservoir; furnishing and installing remote control and telemetering system for Andarko aqueduct; and modifying sleeve valve in outlet works of Fort Cobb dam.	Paramount Construction Co., Inc., Oklahoma City, Okla.	166,603
DC-5421	Central Valley, Calif.	Dec. 12	Construction of earthwork, pipe lines, and structures, including 10 pumping plants, for laterals 57.9, 59.3, 60.9 and 62.9 and sublaterals, Stone Corral irrigation district, Friant-Kern canal distribution system.	Cala Construction Co., Orange, Calif.	1,189,092
DS-5422	Central Valley, Calif.	Dec. 14	Furnishing and installing two 55,555-kva Generators for Trinity powerplant.	General Electric Co., Denver, Colo.	1,428,445
DC-5423	Missouri River Basin, Mont.	Dec. 13	Construction of earthwork, structures, and surfacing for access road for Yellowtail dam.	Husman Brothers, Inc., Sheridan, Wyo.	157,781
DC-5426	Lower Rio Grande Rehabilitation, N. Mex.	Dec. 16	Clearing, and construction of earthwork, concrete lining, and structures for rehabilitation of I lateral system.	E. and M. Bohuskey Construction Co., Harlingen, Texas.	685,061
400C-149	Provo River, Utah	Nov. 4	Construction of Carlile and Diamond Bar-X dikes for Provo River channel revision.	Thorn Construction Co., Inc., Provo, Utah.	265,079
400C-152	Colorado River Storage, Utah-Wyo.	Oct. 24	Clearing 35,000 acres of second phase of Flaming Gorge reservoir site, Schedules 3 and 4.	Edman and Co., Gypsum, Colo.	188,000
DS-5402	Missouri River Basin, Iowa	Dec. 23	Two 75,000/100,000/125,000-kva and one 45,000/60,000/75,000-kva autotransformers with lightning arresters for stage 04 additions to Sioux City substation.	American Elin Corp., New York, New York.	375,315
100C-430	Columbia Basin, Wash.	Dec. 29	Construction of earthwork and structures for 7 miles of DW239, DW52, DW239C, and DW239C2 drains and W54 wasteway, Block 78.	A. R. Sime, Kennewick, Wash.	162,153

U.S. GOVERNMENT PRINTING OFFICE: 1960 O—578670

Major Construction and Materials for Which Bids Will Be Requested Through February 1961*

Project	Description of Work or Material
Central Utah, Utah	Constructing about 10.5 miles of Stanaker Service canal with bottom width varying from 18 feet to 4 feet of which about 2.8 miles will be earth-lined and appurtenant structures, including about 0.7 mile of 12-foot bottom width reinforced concrete bench flume. Near Vernal.
Collbran, Colo	Completing the construction of Upper and Lower Molina powerplant structures, including the installation of powerplant and switchyard equipment. About 40 miles east of Grand Junction.
Do	Furnishing and constructing 4.75 miles of 115-kv, wood-pole transmission line and 6.12 miles of joint power and telephone lines. Upper Molina-Lower Molina and Bonham-Cottonwood, near Collbran.
Do	Constructing a reinforced concrete outlet works about 35 feet below the present crest to connect Bonham reservoir to the 33-inch pipeline now under construction, constructing a spillway, improvements along the crest of the existing Bonham dam, and constructing a small diversion structure on East Fork Creek to divert 30 cfs into East Fork feeder canal, about 1 mile of 30-cfs-capacity unlined canal, a small diversion structure on Atkinson Creek to divert its flow into the East Fork feeder canal, 0.15 mile of 35-cfs unlined canal into Bonham reservoir, a headworks structure, Parshall flumes, terminal drops, an operating bridge, drain inlets, and a turnout structure along the East Fork feeder canal. Near Collbran.
Colorado River storage, Arizona-New Mexico.	Clearing right-of-way, constructing footings, and furnishing and erecting steel towers for about 160 miles of 230-kv, single-circuit Glen Canyon-Four Corners transmission line. From Glen Canyon dam to a point about 12.5 miles northwest of Shiprock, New Mexico.
Colorado River storage, Arizona.	Furnishing and installing eight 125,000-kva, 90-percent power factor, 150-rpm, 13,800-volt, 60-cycle, vertical-shaft, a-c generators for Glen Canyon powerplant.
Colorado River storage, New Mexico-Colorado.	Clearing about 3,000 acres of Navajo reservoir area. About 40 miles east of Farmington, New Mexico.
Colorado River storage, Utah-Colorado	Furnishing and constructing H-frame wood-pole transmission line consisting of about 39 miles of 138-kv line; 125 miles of 115-kv line; and about 8 miles of 69-kv line. Vernal-Oak Creek, Kremmling-Green Mountain, and Kremmling-Gore Tap transmission lines. From Vernal, Utah, to Oak Creek, Colorado; from Kremmling, Colorado, to Green Mountain Dam, located about 10 miles south of Kremmling; and from Kremmling to a point about 8 miles north of Kremmling.
Hammond, N. Mex	Constructing the Hammond diversion dam consisting of a rockfill overflow weir section with a concrete cutoff wall 350 feet long, a compacted earthfill dike 850 feet long, a radial-gate-controlled sluiceway structure, and a headworks structure with slide-gate controls and about 500 feet of 10-foot bottom width canal. Near Farmington.
Minidoka, Idaho	Constructing the East Burley substation.
MRB, Iowa	Furnishing and constructing about 213 miles of 161-kv, wood-pole transmission line. Sioux City-Spencer and Sioux City-Denison-Creston lines. From Sioux City to Spencer, Iowa, and from Sioux City to Creston, Iowa.
Do	Constructing additions to the Sioux City substation (Stage 04).
MRB, Montana	Constructing facilities for a community of about 350 persons. Work will include streets, water and sewer mains, furnishing and installing a water supply system. Yellowtail Government camp, about 45 miles southwest of Hardin.
Do	Constructing a 112- by 36-foot wood-frame administration building, a 75- by 30-foot concrete masonry garage and fire station, a 54- by 39-foot wood-frame laboratory, and a 100 by 40-foot metal warehouse. Yellowtail Government camp, about 45 miles southwest of Hardin.
Do	Constructing fifteen 3-bedroom residences. Yellowtail Government camp, about 45 miles southwest of Hardin.
MRB, Nebraska	Constructing the 1,400,000-cubic-yard Merritt earthfill dam, 120 feet high and 3,100 feet long, and appurtenant structures; and constructing about 25 miles of access road, including a timber bridge. On the Snake River, about 25 miles southwest of Valentine.
Do	Constructing seven county road bridges each about 80 feet long. Alternative designs will be provided. Along the Sherman Feeder Canal near Arcadia.
Do	Earthwork and structures for about 15 miles of the Farwell Main canal with bottom width varying from 32 feet to 22 feet, about 2 miles of the Farwell Central canal with a bottom width of 14 feet, and about 23 miles of laterals with bottom width varying from 6 feet to 3 feet. Near Farwell.
Do	Earthwork and structures for about 18 miles of the Farwell Main canal with bottom width varying from 22 feet to 4 feet, and about 5 miles of the Farwell Lower Main canal with bottom width varying from 10 feet to 3 feet.
Do	Replacing a 36-inch-diameter precast-concrete pipe siphon with a 42-inch-diameter siphon, and constructing about 2 miles of compacted earth lining in existing canal. Bostwick canal, near Lovewell, Kansas.
MRB, North Dakota	Constructing additions to the Grand Forks substation (Stage 02).
MRB, South Dakota	Constructing additions to the Watertown substation.
Rogue River Basin, Oregon	Rehabilitating about 12.5 miles of unlined lateral and constructing about 9 miles of lateral. West lateral, near Medford.
San Angelo, Tex	Clearing about 9,000 acres of the Twin Buttes reservoir area. Near San Angelo.
Weber Basin, Utah	Constructing about 9 miles of the earth-lined Willard canal, near Ogden.

*Subject to change.

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The Reclamation Era

MAY 1961 **VOLUME 47, NO. 2**

In this issue . . .

VIOLET PALMER, Editor
THEODORE R. McCANN, Artist

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reclamation's ECONOMIC $$$$$$$$$$$$ impact

America's westward movement of population continues in greater numbers than ever and the capacity of the West to absorb these migrating millions is linked inextricably with the availability of water for agriculture, industry, and homes.

The East, besides finding room in western areas for its expanding population, has a great stake in western development since the new farms and homes and even the industries of the West become markets for the more mature economy of the East.

This then is a tale of the economic impact of western water development projects, not only on the West but on the East as well. It is a tale of the interrelation and interdependence of diversified agriculture and commerce and industry, where each segment is a supplier and at the same time a consumer.

Although industry is developing now in the region that was once predominantly agricultural, the West continues to draw the bulk of its manufactured materials and machinery from the industrial East and South. It thus constitutes a large and still growing market for the manufacturing which is the economic base of those areas. The stimulus that Reclamation thus provides to commerce east of the Mississippi not only helps make a market for products of Reclamation farms, but for products of American agriculture as a whole.

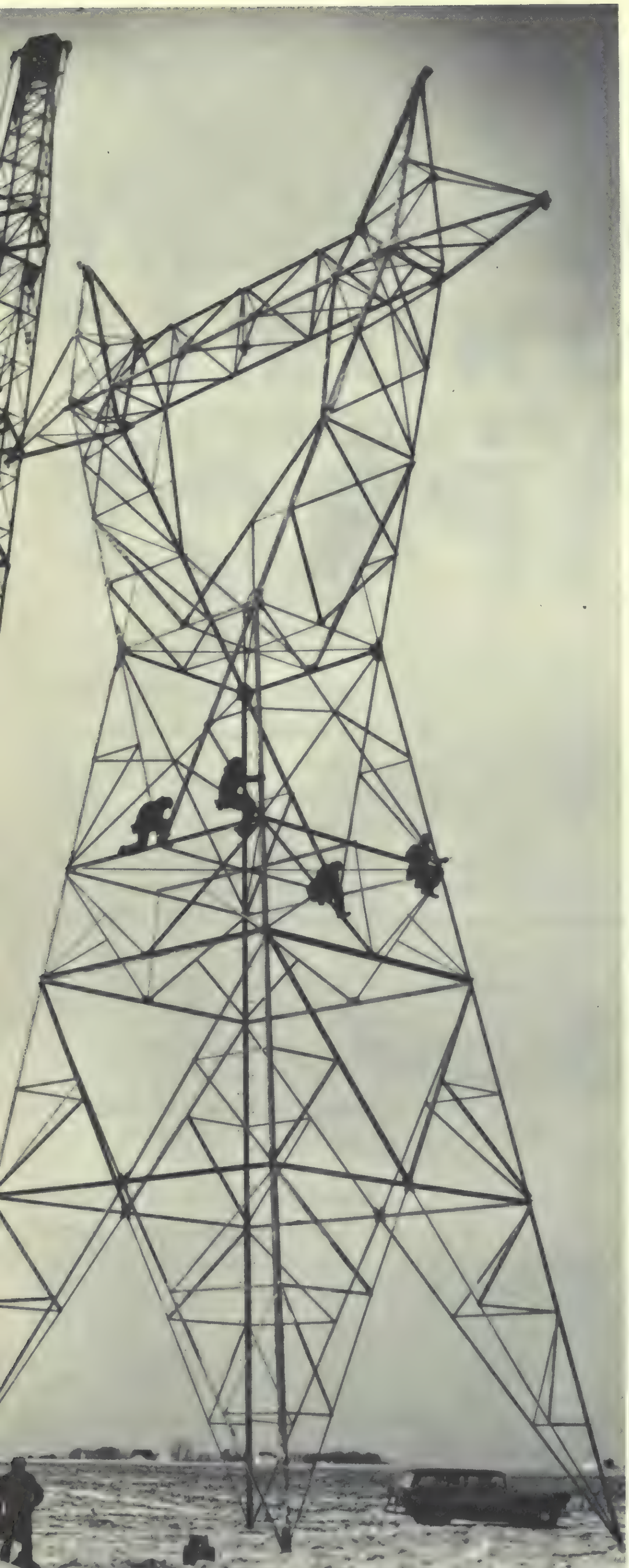
Examination of a few statistics of the program will lead to a better understanding of the nature of Reclamation's impact on economic and human values. Seven million acres are irrigated with water from Reclamation reservoirs and canals. About 200 municipalities or other nonfarm entities also use project water to the extent of 290 billion gallons annually. There are 42 hydroelectric powerplants on Reclamation projects rated at more than 5 million kilowatts capacity.

These main elements comprise the core of the Reclamation program. What does it represent in terms of farms and homes, in jobs and business opportunities, living standards, new industry and security?

There has been remarkable success in combining the raw lands and scarce waters into a single productive resource. Some 129,000 irrigators have established adequately watered farms, providing livelihood for not only their own families but for an equally great number of farm wage earners. From this type of economic base has sprung the prosperous community development which characterizes the entire Reclamation West. Now 1¾ million persons make their homes on lands irrigated from Reclamation systems.

More than 8 million persons live and work in the cities and towns which draw on Reclamation

by ROBERT E. STRUTHERS, Economist, Washington Office



projects for water supplies. Human existence would be virtually precluded and industry could not operate without an assured source of water. The growth of these urban centers continues only by virtue of the available water.

Outdoor recreation in the parched western region of the United States is seldom accorded the name unless it takes place at a stream or lake. The large Reclamation reservoirs provide water recreation on a huge scale. In 1959, the usage of these facilities amounted to nearly 23 million visitor-days.

The impoundment of water supplies has created hundreds of miles of new shoreline and more than 1⅓ million acres of water area. These large lakes have a greater attraction for pleasure-seekers each year. Visitations were 17 percent greater in 1959 than a year earlier. Business enterprises which cater to the needs of these lovers of the out-of-doors are reaping a rich harvest.

The silent surge of electrical energy from the Reclamation power systems in 1960 was enough to satisfy the requirements of 6 million persons. Incidentally, the usage of electricity in Russia is so restricted that this amount of energy would be stretched to serve 23 million persons there.

In addition to the water supplies and hydroelectric power that Reclamation provides, there are significant benefits from the prevention of floods, abatement of siltation and pollution in our streams and from enhancement of wildlife and fish habitat.

The nucleus of commerce that is formed where water resources are developed proves to be a fertile field for further economic growth. The pattern of expansion typically progresses from extensive to intensive farming, from crossroads village to town and to city, from a paucity of community and public service institutions to variety and abundance of the features of good community life. The origin of this vigorous growth pattern obviously is in the output of farm products, not of products already available, but those farm products for which there is a growing demand.

Bureau of Reclamation surveys show that the modern processing plants that receive, clean, sort, can, freeze, package, or otherwise prepare the products of Reclamation farms for the market have an aggregate capital investment worth up-

ward of three-quarters of a billion dollars. The activities of these plants add about a half-billion dollars to the value of the farm products in preparing them for the consumers' use.

Payrolls for some 54,000 man-years of employment in these plants add up to $177 million annually. This is a part of the diversified economic base that follows irrigation development. Add to this the establishments that provide the consumer goods and services these workers and the farm workers buy with their wages. These bustling trade centers eventually become wholesale trade centers and attract light industry.

Not to be overlooked are the widespread favorable influences which this western growth has upon the other parts of the country.

To produce their billion-dollar harvest last year, Reclamation farmers had to lay out a third of a billion dollars for manufactured and industrial goods. Commercial fertilizers and chemicals, a demand which was almost nonexistent 30 years ago, cost these irrigators some $65 million. Mechanization on these farms is essential but costly. It provides a market for $59 million worth of tires and other rubber products; farm machinery, trucks and autos; and repair parts and services. This is illustrative of the magnitude of the farm market demand that year after year has drawn to the West the manufactured and refined products of the industrially developed parts of the Nation.

Competent estimates show that the building of a major Reclamation dam will have an influence on business in practically every State. A study involving purchases of equipment and materials for Glen Canyon Dam on the Colorado River revealed that the induced business over and above the basic purchases for construction amounted to approximately the same dollar value as the basic expenditure. This means that a dollar spent for direct purchases and payroll for construction gives rise to another dollar's worth of trade in the economy.

Only about one-fourth of the construction dollar was spent at the damsite, the remaining three-fourths going to 47 States, England and Canada—to the supply sources of steel, cement, machinery, and other industrial goods. Taking account of induced business, the off-site trade and commerce amounted to about $6 for every dollar spent at the damsite.

Now, granting the beneficial economic impact of water resource developments in the West, what of the question concerning possible conflict in the philosophy of reclaiming land for farming when

Continued on page 49

Dairy farmer is customer for machinery to cut hay and supplier of milk in interdependent economy.


Under Secretary Carr (left) and Assistant Secretary Holum.

MEMBERS OF INTERIOR'S NEW TEAM

Two of the men who are helping Secretary Stewart L. Udall guide the Department of the Interior are new to their present positions but not to the task at hand—that of conserving and developing natural resources for the widest possible benefit.

Under Secretary of the Interior James K. Carr and Assistant Secretary Kenneth Holum, though from different regions and with different backgrounds, have a common record of public service, much of it in close proximity to the public they served.

Under Secretary Carr, who has a wealth of experience in water resource matters, has stated this view of Reclamation: "We are definitely aware of the need to expand the Federal Reclamation program to keep pace with the country's growth. Western reclamation areas, for the most part, do not produce surplus crops and there isn't any question that crops grown on western reclamation projects are those vital crops that improve the national diet. These reclamation projects have been islands of stability during periods of recession. They have slowed the migration of our young people to the cities because they make a better living possible on the land.

"More than that, they have stimulated industrial development and manufacturing enterprises in the Midwest and Eastern States which supply the fabricated materials for these huge projects."

Mr. Holum, who discharges the duties of the Secretary in the water and power fields, sums up his philosophy on such resources this way: "The growing demands of an increasing population and an expanding industrial economy have placed added emphasis on the importance of conserving our natural resources and developing them in the public interest.

"The amount of water available to supply our domestic, industrial, and municipal requirements is limited. Our exploding population needs more land capable of producing protein- and vitamin-

Continued on page 50

the water's fine IF!

And that big IF is:

IF you swim and IF the water is open to the public for water sports. Otherwise, the word is Stay Out and Stay Alive.

Over 80,000,000 Americans cannot swim—and yet in 1960 an estimated 100,000,000 citizens participated in some form of recreation involving water. There are 3,000,000 water skiers; 500,000 skin divers; and 10,000,000 boats in use! And the American public is becoming more and more water recreation minded each year.

The problem is: What can be done to alert these citizens to water dangers, and how can they learn to enjoy water recreation in safety and without risk.

In 1957, the Commissioner of Reclamation and the President of the American Red Cross met to discuss the problem of public awareness to water safety in the area of operation of the Bureau of Reclamation. "Operation Westwide," a water safety program, was born at this meeting.

"Operation Westwide" is a plan whereby the Red Cross and the Bureau actively promote and support a program of public education in water safety and accident prevention. To get the plan underway, it was decided to start in a few selected communities which very definitely had existing water safety problems.

Two such pilot project areas were selected in Region 1 of the Bureau of Reclamation which encompasses the States of Oregon, Washington, Idaho, and portions of Montana and Wyoming west of the Continental Divide. The two selected pilot projects were the Yakima project in central Washington, and the Boise project in southwestern Idaho.

The Columbia Basin project in the Big Bend country of the Columbia River in north-central Washington had already had a similar program in operation since 1951, the year irrigation water was first made available to project lands. This program was further implemented and is now highly successful.

The Yakima project, which has been in stage construction since 1905, had a different problem. The people had grown up with both natural and man-made waterways and there was some inertia about changing their way of thinking to recognize that a rapidly increasing population, coupled with the trend toward water sports as a form of recreation, had magnified the water safety problem.

In line with the objectives of "Operation Westwide" the following pattern of organizing community water safety committees was employed:

1. A representative of the Bureau contacted the local Red Cross representative in order to find out who was who in the area.

2. Personal interviews were then arranged with prominent leaders in the community. These key people were told of the local water safety problem and were asked to attend a public meeting and to present a 3-minute talk on how they thought the problem should be solved.

3. The various news media were contacted to publicize this meeting and its purpose, inviting anyone interested to attend.

by HAROLD E. WERSEN
Regional Safety Engineer, Boise, Idaho

4. Public meetings were held, with Red Cross and Bureau of Reclamation representatives presenting the problem and then calling on the previously arranged speakers to present their views. The discussions generally centered on one basic fact: The program of the group should not be one of prohibition, but rather one aimed at education of the public. The educational program has one basic objective, and that is to develop a safety conscious public on, in, and near the water. At the conclusion of the meetings it was found usually that enough interest had been aroused that these citizens would eventually elect a temporary set of officers and set a date for the next meeting. In nearly every instance representatives of the press and radio attended these meetings. Publicity didn't have to be solicited, although it was certainly welcomed.

5. The second meeting usually resulted in the election of permanent officers and the appointment of people to the following sub-committees: Public Education, Legislation, Boat Safety, Membership, and Publicity.

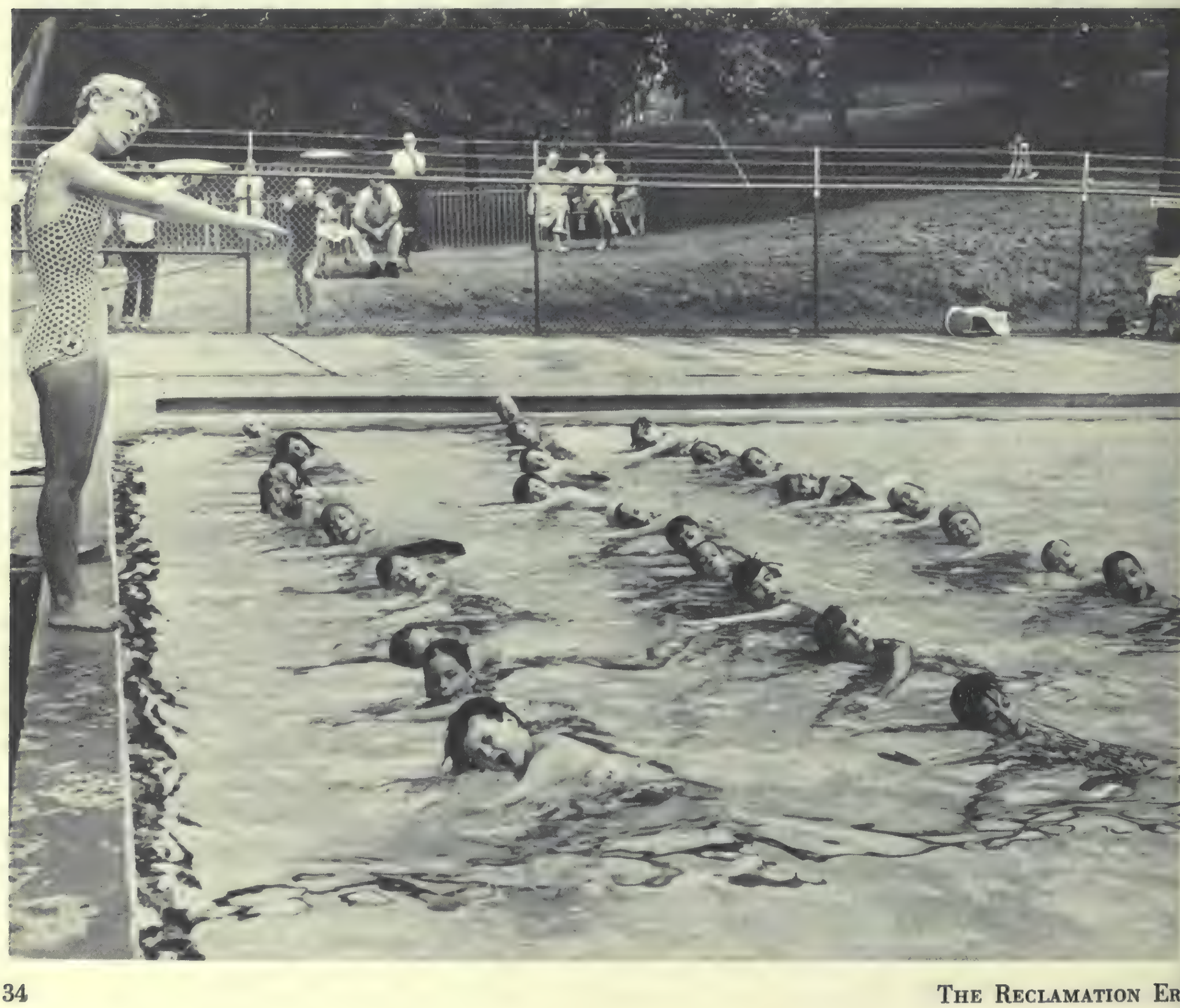
6. The subcommittee's goals and purpose were then discussed and the line of action agreed upon. These subcommittees meet as often each month as they think necessary, and then make recommendations at the regular monthly meeting of the Water Safety Committee.

Subcommittee activities usually include:

Public Education

This subcommittee promotes in every way possible the Red Cross swim program which is pointed toward greater public respect for water by encouraging more people to learn to swim.

One answer to the water safety problem: Swimming instruction for the young and eager. ***(Red Cross photos)***



The Yakima Valley Committee jumped the annual average number of swim certificates awarded from a previous high of 9,000 to 27,166 certificates in 1960.

Where there is an established Coast Guard Unit the committee and the Red Cross collaborate with the Coast Guard in establishing small craft training sessions aimed at educating boat owners in proper and safe handling of boats. One community on the Yakima project has awarded nearly 500 certificates for this 20-hour course.

This committee in the Yakima area also sponsors water safety poster and slogan contests from the fourth grade through high school. Businessmen furnish the prizes for these contests. In one contest there were over 600 contestants and on the night when awards were made to winners several hundred people attended.

Legislation

This subcommittee helps draft legislation that will regulate the safe use of water recreational areas through authorizing action by local authorities.

As each State already has various existing basic laws, this subcommittee usually enlists local legal talent to help with the problem.

Membership

This subcommittee represents no special interest. Its success depends upon enlisting the aid of members from sportsmen's clubs, parent-teacher associations, law enforcement officials, boating clubs, youth organizations, granges, civic service clubs and others. For example in Region 1, one water safety committee numbers representatives of some 40 organizations in its membership.

Publicity

This subcommittee enlists all forms of news media in the water safety effort. Throughout the Pacific Northwest, news outlets cooperate fully in the public interest. Water safety items are kept before the public by the area's newspapers, television and radio.

Drownings and near-drownings get full publicity, and special emphasis is given in the news stories on how such accidents could have been prevented. Two community water safety organizations have made outstanding panel presentations on water dangers in the Yakima area over television.

This is the basic outline of organization of the "Operation Westwide" Community Water Safety Committees in the Pacific Northwest. There are now five such program areas established. Two additional areas where construction of irrigation facilities will be completed and the public will be participating in recreational activities in the near future are organizing water safety programs.

Volunteer instructors undergo training; later will teach youngsters over six years to swim—and to observe rules of water safety.

These local committees send monthly reports to the Regional Office of the Bureau of Reclamation so any new ideas they may develop are passed on to other areas. By the same token, from these reports the effectiveness of each program can be readily evaluated.

After the community committees are organized, the Red Cross and Bureau of Reclamation representatives merely act as exofficio members. "Operation Westwide" is a program "of the people, by the people, and for the people." On this basis, people decide for themselves, and the Bureau and the Red Cross participate in an advisory capacity only. The Bureau supplements community effort by posting warning signs at all critical or hazardous spots on all of its installations. These signs explain the danger and appeal to the public for cooperation in safety efforts.

Finally, there is another asset in this program. The National Safety Council approved and set up the first session of the Recreational Boating and Water Safety Section at the 1960 National Safety Congress. From now on, through the National Safety Council, community water safety commit-

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Century of Service

An aggregate of more than a century of Federal Service, most of it in the Bureau of Reclamation, is represented in three recent retirements—Alfred R. Golzé, Assistant Commissioner for Administration, who retired in February; John J. McCarthy, Editor of The Reclamation Era, who retired at the end of last November; and Elmer Moten, who retired on March 31.

ALFRED R. GOLZÉ

Assistant Commissioner Golzé retired from the Bureau to accept the position of chief engineer of the California State Department of Water Resources. He reported for duty at Sacramento on February 20. His appointment resulted from a nationwide State Civil Service examination held last June.

Mr. Golzé began his public career as a junior civil engineer in the Interstate Commerce Commission in 1930 and transferred to the Bureau of Reclamation as a design engineer in the Denver Office in 1933. In 1943 he went to the Bureau of the Budget in San Francisco as an assistant field representative and conducted a study of western water development plans.

He returned to the Bureau of Reclamation in 1945 as assistant director of the Branch of Operation and Maintenance. He became director of the Program and Finance Division in 1947 and under his direction the program and budget operations of the Bureau were modernized to meet Congressional requirements and Bureau management needs. He became an Assistant Commissioner in February 1958.

Mr. Golzé, a native of Washington, D.C., is a graduate in civil engineering from the University of Pennsylvania, with post-graduate studies at the University of Colorado and George Washington University.

JOHN J. McCARTHY

Mr. McCarthy's Federal service began with the Department of Agriculture in 1928 and he came to the Bureau of Reclamation in 1930.

He worked successively as a clerk in the mails and files section, assistant chief of the section, research assistant to the chief of information, information specialist, and since 1954, editor of *The Reclamation Era.*

Mr. McCarthy retired last November due to ill health. He continues to make his home in his native Washington, D.C.

ELMER MOTEN

Mr. Moten who retired on March 31, at 56 years young, had served with the Federal Government for 42 years. At the time of his retirement he was Mail and File Supervisor in the Washington Office. He was first employed as a youngster of 13 by the War Trade Board. Later he transferred to the General Land Office (now Bureau of Land Management) where he was employed from October 1919 until August 1948, when he came to the Bureau of Reclamation. # # #

the people's choice

"This land breeds strong-willed men; they'll make their own choice," the Bureau of Reclamation's Region 5 director, Leon W. Hill, said when a reporter asked him to speculate on the outcome of the election held last November to determine whether or not the Canadian River project in Texas would be built.

And they did just that. The people demonstrated by one of the heaviest votes in the history of the area—28,000 to 1,000—that they recognized the necessity for the project, understood how it must be paid for, and intended to have it just as soon as the Bureau of Reclamation could build it.

Farsighted citizens of the High Plains have been aware for many years that the surface water supplies of the Canadian River should be developed to augment and conserve the ground water which is used as a source of municipal water and irrigation throughout the area. They saw their future progress locked in the waters that flow sometimes at floodstage across the Texas Panhandle.

Following the favorable vote, the Canadian River project repayment contract was executed on behalf of the Canadian River Municipal Water Authority by the organization's president, C. T. Johnson, and on behalf of the United States by Regional Director Hill in Plainview, Tex., on November 28, 1960. This contract is the largest dollar repayment agreement in the history of the Bureau of Reclamation. The project cost is estimated at $96,090,000, of which $92,960,000 is reimbursable. Such benefits as flood control and fish and wildlife improvement are nonreimbursable.

In its simplest terms, the project will consist of a dam on the Canadian River, 9 miles northwest of Borger at the Sanford site, and pipelines and pumping plants to deliver water to municipal systems of the 11 member cities, which are: Amarillo, Borger, Brownfield, Lamesa, Levelland, Lubbock, O'Donnell, Pampa, Plainview, Slaton, and Tahoka. The Canadian River Dam will be of earthfill construction, and will cost about $31,000,000. The aqueduct system, containing 322 miles of reinforced concrete and steel cylinder concrete pipe, with necessary pumping plant and regulating pools, is estimated to cost $65,030,000. The pipe will range in diameter from 72 to 15 inches.

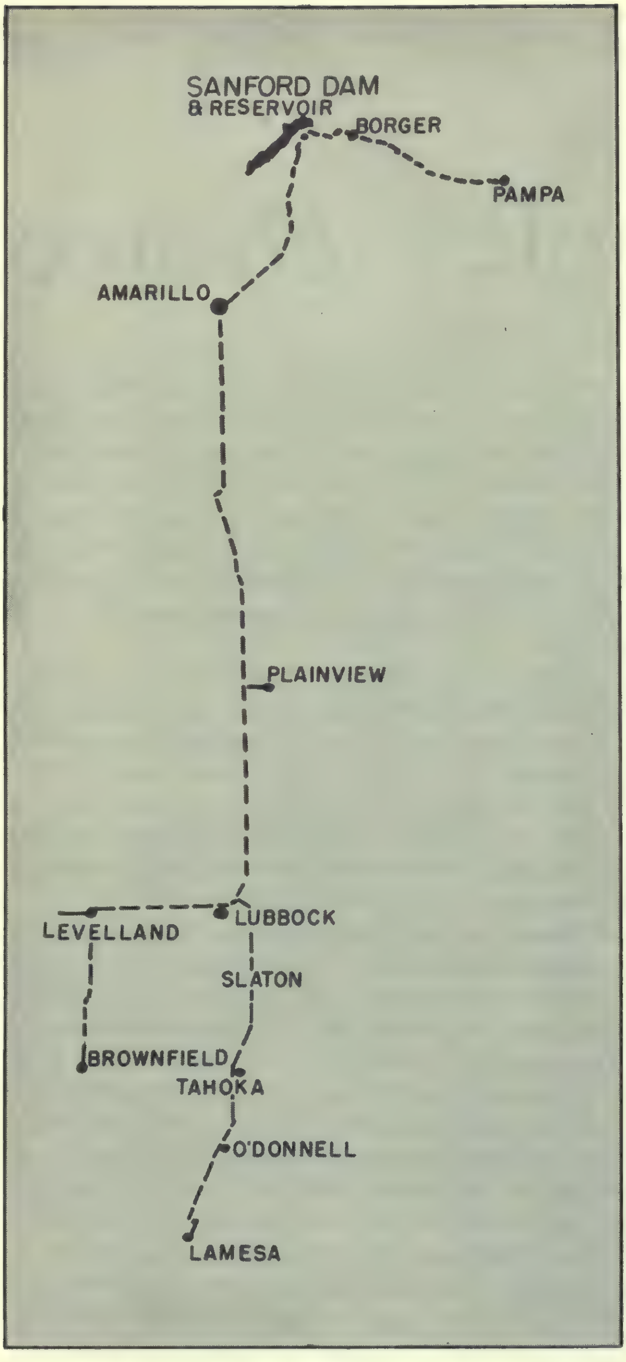
Invitations to bid on the dam will be issued this fall, assuming sufficient funds are appropriated by the Congress. About 4 years will be required to construct the dam. The construction of the aqueduct system will require approximately 5 years, and will be started the year after the dam is started. Total construction period is expected to be about 7 years.

The signing of the contract was the culmination of years of planning. Hope for the dam faltered many times over the past decade, and on many occasions was almost abandoned. Authority Secretary A. A. Meredith—"Double-A," as he is affectionately called by his many friends of the area—would not relinquish the dream of proper use of Canadian River water, and again with cheerful persistence, breathed new life into the plan which will run Canadian River water to the taps of homes in the 11 member cities.

As far back as 1936, people of the area began trying to work out a means to finance the dam. The first positive steps were finally taken when, in 1949, the Bureau of Reclamation presented its report stating that the project was feasible as a municipal and industrial water supply. In December 1950, the Senate passed the authorizing bill and the President signed it into law on December 29, 1950.

For most of the next decade, the cities studied various means of financing the project and meth-

by MARY ELIZABETH KISNER
Regional Office, Amarillo, Texas



Canadian River Project will serve these eleven Texas cities.

ods of apportioning the costs to the member cities, but agreements were not reached.

The drought-burdened fifties were sad days for Texans living along the Canadian. High Plains city governments wrestled with the problems of depleting water tables, higher prices, and decreasing availability of lands on which to drill wells to furnish municipal water. An undependable future water supply discouraged development and extension of industry. City leaders pushed their Stetsons to the backs of their heads and looked to the land they loved. Time was past for talking; it was time for doing.

They turned as a man to Authority Secretary Meredith. They elected C. T. Johnson president of the Authority. A Pricing Formula Committee was appointed and began to function immediately in its efforts to bring about agreements among the cities on allocation of costs and water. Mayor A. F. Madison of Amarillo and Mayor David Casey of Lubbock, after a series of difficult negotiations, paved the way for the smaller cities by reaching agreement on pricing formulas for their cities on May 27, 1960.

Amarillo and the northern cities, recognizing the recreational benefits that would result from the reservoir, agreed to pay all the cost of the dam and reservoir, which considerably lessened the burden of the cost of the smaller southernmost cities. The cities to the south, because of their distance from the dam and reservoir, would have to pay a greater cost for the aqueduct.

The Canadian River Authority, as constituted, represents the 11 member cities with two directors from each city. These directors and the mayors of the member cities worked long and diligently in deriving the final formula for apportioning the costs of the great project. Each city had studies made to support its position as to how much it could afford to pay for the future water supply from the project. In the Authority meeting at Plainview September 12, 1960, final agreement was reached, much to the credit of all members of the Authority and the city officials who participated in the negotiations.

In line with their "action policy," citizens and members of the Authority, through their Congressional delegation, asked for $300,000 which was appropriated to the Bureau of Reclamation by the Congress in 1960 to finance contract discussions, up-date estimates and move the project along into the advance-planning stage.

In the repayment contract negotiations, the Authority and the cities recognized the position of the Government in requiring full assurance and necessity of guaranteeing repayment of the cost of the project. "You not only will have the privilege of paying for the project; you must pay for it," Director Hill told the representatives of the cities.

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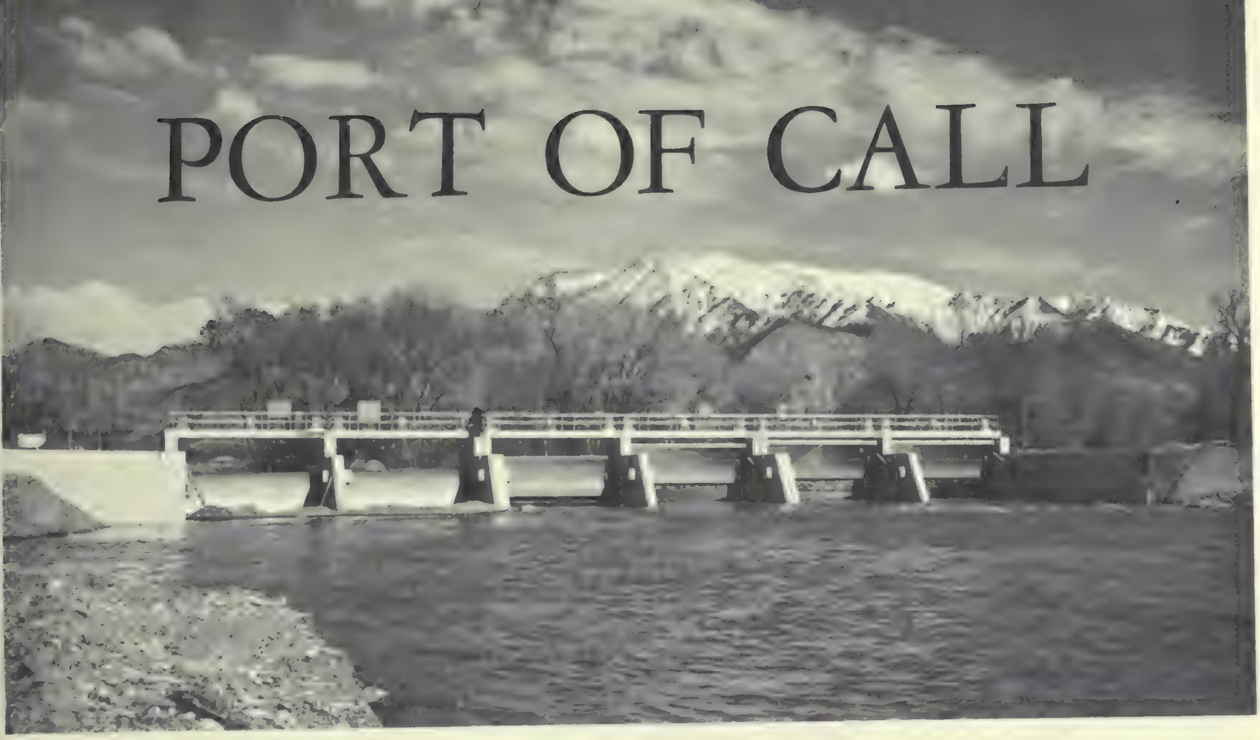

PORT OF CALL

American experience in reclamation is being made available on a world-wide basis through a variety of programs. Under the U.S. Government's technical aid programs, on-the-job training of many foreign engineers and technicians has been provided at Bureau of Reclamation facilities. During 1960, 369 people from 35 countries spent from a few days to a full year studying in Bureau offices. United States reclamation specialists have been sent to countries on every continent to solve specific problems. At State Department request, the Bureau of Reclamation has also provided a number of technical assistance teams on extended duty with foreign reclamation projects—among them are the Helmand Valley irrigation project in Afghanistan, the Blue Nile River reconnaissance project in Ethiopia, the Litani River Project in Lebanon, and the Snowy Mountain Hydroelectric Project in Australia. The cost of such foreign activities is borne by non-Reclamation funds.

Each year, more than 300 foreign engineers and technicians come to see firsthand—to learn "on the job"—how the Bureau of Reclamation meets and handles the problems involved in development of water resources under the American democratic system. They pick up useful ideas, both technical and nontechnical, that cannot be found in textbooks and which are beyond the experience available to them in their home countries. They come from nations on every continent, but mostly from the so-called under-developed countries.

Many foreign technicians find the Weber Basin project, near Ogden, Utah, listed as a "port of call" on the itineraries worked out for them by the Foreign Activities Division of the Bureau of Reclamation.

The Weber Basin project is not as well known as some of the more spectacular members of the growing family of Reclamation projects, but is conveniently located on main travel routes and near the geographical center of the Bureau's vast area of responsibility. Foreign visitors often find here, where the modern practice of irrigation in America had its beginning, the very things they had hoped to see on their tour of Reclamation projects.

A typical comment goes something like this: "We have enjoyed our visit to Glen Canyon

by HAROLD E. DEAN, General Engineer, Weber Basin Projects Office, Utah

Weber Basin's Gateway Canal, looking upstream above headworks of Gateway Tunnel. Wier at left provides against over-topping.

damsite, Hoover Dam, Shasta Dam, Grand Coulee Dam; but we cannot hope to build such great structures in our country. We can hope to build smaller dams and canals, pipelines and pumping plants like we see on the Weber Basin project."

To help the visitor understand this rather complex project, maps, pamphlets, and "homemade" movies are used. With pictures and drawings, it is possible to help bridge time, distance, and even language difficulties. A typical one- or two-day tour consists of visits to parts of the project, including the main construction activities, and then interviews, discussions and a movie or two.

Learning is necessarily a gradual process, and it seems doubly so when ordinary communication is hampered by the language barrier. But it is heartening to see a visitor's eyes light up when he sees in a construction activity, in a completed structure, or in an operating procedure, a solution to some particular problem he has encountered in his own country. It might be said that the number of ideas a visitor picks up is directly proportionate to his past experience and to his own curiosity and imagination.

Most visitors are interested in the construction of Willard Dam, a long, earth dike being built on a foundation which is mostly soft mud. Willard Dam suggests to some visitors heretofore undreamed of possibilities for storage facilities in coastal areas. Others are more interested in construction methods and in the experience of the contractors at Willard who have experimented with a variety of earth-moving equipment. Mimeographed copies of a technical report on Willard Dam foundation problems are made available to those visitors who are particularly interested.

Other visitors seem most impressed with the concept of multiple-purpose development as seen on the Weber Basin project, where the cost of irrigation development is shared by municipal and industrial water, and to a lesser extent by recreation and fish and wildlife allocations.

Many are intrigued by the idea of the ultimate development of water supplies. The Weber Basin area is not blessed with an abundance of water but must strive to conserve and put to the best possible use every drop of the available water supply.

Somewhat surprisingly, only a few of the foreign visitors seem to be concerned with the details of engineering design. Perhaps they get enough of that during their stay in the Bureau's technical center in Denver, Colo. Far more interest is shown in the relationships with the water users, land owners, local governments and the general public. How does the Federal Government, in a democracy, deal with its own people on such matters as water rights, right-of-way acquisitions, etc.? Such problems are worked out on the Weber Basin project as elsewhere on Reclamation projects.

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Draglines in operation at Willard damsite. Instability of earth in area precludes use of heavy earth-moving machinery.

RECREATION at man-made lakes

PART I

The great northwestern corner of the United States is a land of golden opportunity for the recreation-minded. From the Red River of the North, across the wide Missouri, and from the towering, glacial peaks of the Continental Divide to the rugged coastline of the Pacific, the traveler is constantly surrounded by nature's finest, augmented by some of man's best achievements.

Within the Upper Missouri River Basin, the area contained in the Bureau of Reclamation's Region 6, there are more than a score of man-made lakes, the reservoirs formed by multiple-purpose dams constructed by the Bureau to serve many uses.

Westward in the Bureau's Region 1, the Pacific Northwest—bountifully endowed with many natural lakes and rivers—also has spectacular man-made reservoirs and waterways which are receiving greater recognition each year as top vacation areas.

To recount the varied fare awaiting the traveler across the northern tier of States—with Fargo, N. Dak., as a starting point—would require an epic-size book. Here only a few of the highlights can be mentioned—in the way of man-made lakes and, nearby, the natural scenic attractions and the western celebrations and festivals. Even at that, much will be left out. What follows is more or less a sample, an appetizer.

Following the course of U.S. Highway No. 10 (now also known as No. 94), about 860 miles lie

between Fargo, N. Dak., on the Minnesota boundary, and Pipestone Pass, on the Continental Divide of the Rocky Mountain Range, near Butte, Mont.

On such a journey, the traveler will see the famous Red River of the North, cross the moraine that constitutes the divide between the Hudson Bay drainage basin and the Missouri drainage basin, see the plains, badlands, rolling hills, the irrigated valleys and the mountains.

It is only 95 miles from Fargo to Jamestown, adjacent to the Bureau's Jamestown Dam and reservoir, on the James River, the first completed feature of the proposed 1,000,000-acre Garrison Diversion Unit.

Sightseeing, picnicking, camping, swimming, boating, water-skiing, fishing and hunting are to be enjoyed at the 2,100-acre lake which is administered by the Stutsman County Park Board. Three double launching ramps, 55 picnic tables, 24 fire grates and other facilities are available. A concession site provides for various visitor needs.

Continuing west on U.S. 10, it is about 100 miles from Jamestown to Bismarck, North Dakota's capital city, with its modern skyscraper capitol looming above the prairie. Here, too, the wide Missouri River divides Bismarck and Mandan.

The Missouri is now a subdued stream, harnessed by the Corps of Engineers' Garrison Dam, located 77 river miles upstream, one of the largest rolled-fill earth embankments in the world. Garrison Reservoir, having an area of 369,500 acres at normal recreation pool, and a length of 200 miles, is a prairie dream of boaters. Each year during the Fourth-of-July holiday, a water- and boatshow is held at Garrison Bay on the north shore, near the town of Garrison.

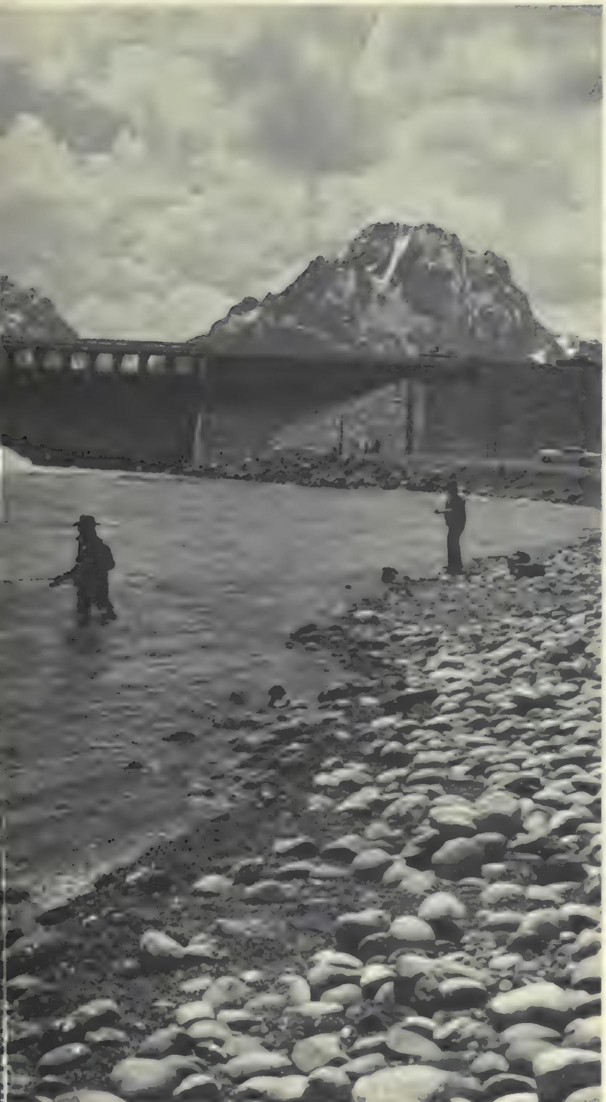
As the tourist leaves Bismarck, he will cross the Missouri and see the rolling hills surrounding Mandan. An historical outdoor drama, "Trail West!," sponsored by the Mandan Historical Development Association, is held there Wednesday through Sunday each week during July and August at the General George Armstrong Custer Memorial Amphitheater in Fort Lincoln State Park. The drama recreates the story of Custer and the U.S. Seventh Cavalry.

Detouring southward to pick up one of the areas thus far missed—Angostura Reservoir, in the foothills of the famous Black Hills, has become one of the most popular recreation sites in southwestern South Dakota. The South Dakota Department of Game, Fish and Parks administers the water surface—normally 4,830 acres—and the land on the east and south sides of the lake. A pleasant camping area, for overnight outings, has been developed with tent and trailer spaces. Picnic tables, fire grates, public launching ramps and a swimming beach are used by the many visitors. An enthusiastic statistician has determined that 400,000 sport fish were caught at Angostura during 1959.

The waters below Jackson Lake on the Snake River in Wyoming pro

Within the perimeter of the Black Hills, there are many interesting sites—Wind Cave National Park, Custer State Park, Mount Rushmore National Park, and others.

The Black Hills are famous for their roundups



, while the Grand Teton Mountains form an awesome backdrop.

and rodeos. In early July, the "Black Hills Roundup" is held at Belle Fourche, the home of the Bureau of Reclamation's Belle Fourche project.

Another favorite with vacationists is Shadehill Reservoir, on the Grand River in northwestern South Dakota near Lemmon. Recreational facilities and lands are administered by the State. Access roads, day-use areas, and camp grounds, with tent and trailer spaces, public launching ramp and public boat dock, tables and fireplaces, swimming beach, and other facilities are available.

Returning to North Dakota—the traveler can pick up his westward trail on the Heart River, which in Sioux translation is called Tacanta Nakpa Tanka. It is not a large stream, nor long, but it does have the distinction of having two Reclamation lakes—Lake Tschida, created by Heart Butte Dam near Glen Ullin, and Edward Arthur Patterson Lake, formed by Dickinson Dam, near Dickinson. Both are popular recreation sites.

The lake behind Dickinson Dam, near a major shipping center, is used not only for swimming and boating but for picnicking, fishing and hunting. Adjacent to the swimming beach, the city of Dickinson, which administers the reservoir, maintains trailer and camping facilities for tourists.

The next Reclamation lake is Canyon Ferry Reservoir on the Missouri River near Helena, Mont., within the shadows of the Continental Divide. But long before arriving there, the traveler will have passed through the scenic Badlands and areas of historical moment.

The Theodore Roosevelt National Memorial Park, near Medora, N. Dak., commemorating the beloved "Teddy" who went west in 1883 to ranch and regain his health, is located in this unique area. Medora, on the Little Missouri River, is a mecca for the history-minded tourist and is now being restored as a living museum of the frontier era.

"Old Four Eyes," a colorful drama portraying the life of Roosevelt in the Badlands, staged in the outdoor Burning Hills Amphitheater near Medora, is presented nightly, Wednesday through Sunday, July through August.

At Glendive, Mont., the tourist will first observe the Yellowstone Valley and will soon see the green fields of the Bureau of Reclamation's Buffalo Rapids project, and Miles City, the capital of a great grassland empire. Shortly before he reaches Billings, he will drive through Reclamation's pioneer Huntley project. He will wish to visit many attractions in Billings, the hub of the Midland Empire, and certainly will want to see the Custer Battlefield National Monument, 63 miles southeast on U.S. Highway No. 87.

On a southward excursion toward the Wyoming line, the traveler can reach the north entrance of Yellowstone National Park at Gardner, Mont.

Near Bozeman, Mont., the Missouri River Headwaters State Monument, one of the most important of the West's historical sites, marks the confluence of the Gallatin, Madison and Jefferson Rivers to form the Missouri. Discovered in 1805 by the Lewis and Clark Expedition, the head-

Campfire girls prepare noon snack at their camp bordering reservoir behind Dickinson Dam on the Heart River in North Dakota.

waters today form a living monument to the explorers.

Canyon Ferry Lake, located in a scenic mountainous region, provides many recreational opportunities—sightseeing, fishing, camping, picnicking, swimming, boating, waterskiing. Trout fishing is excellent. The Montana State Parks Division, which administers the recreation areas, has developed nine camping grounds, with a total capacity of 50 tent spaces and 30 trailer spaces, and has constructed picnic tables, fireplaces, wells and shelters. Two concession sites at the lower end of the reservoir provide cabins, meals, docks, launching ramps, boat and outboard motor rental, and fishing and boating supplies.

Nearby Helena, Montana's capital, whose main street runs along the bottom of historic Last Chance Gulch, and the surrounding mountains and valleys also hold many attractions for the tourist. For instance, there is the State Historical Museum and Russell Art Gallery; and "The Last Chancer," a unique train which takes visitors on a tour of old and new Helena, making a stop where the visitor can pan his own gold.

One of the best known of the man-made lakes in the Pacific Northwest is Jackson Lake. With its backdrop of awesome Grand Teton Mountains, the lake, on the Snake River in the Grand Teton National Park of western Wyoming, is enjoyed by nearly a million vacationists each year. It is a gateway to the Pacific Northwest.

The lake is in the heart of the once isolated area known as Jackson Hole, legendary lair of some of the most colorful banditti of the old West. Butch Cassidy and his band of cutthroats roamed the Hole, but they did not know the Jackson Lake of today. This beautiful lake is actually a Bureau of Reclamation irrigation reservoir, built after the turn of the 20th Century to store water for the irrigated farmlands in the Upper Snake River Basin of Idaho.

Native cutthroat, rainbow and mackinaw trout are plentiful in the lake, and the rivers and streams. Boating, mountain climbing, horseback riding—all can be enjoyed. Numerous public camping areas, motels, dude ranches, and the Jackson Lake Lodge offer every type of accommodation to the visitor.

Leaving Jackson Lake, the westbound traveler can drive down the colorful Snake River Canyon to Palisades Reservoir, just over the Idaho boundary. This recently completed Bureau reservoir also offers excellent opportunity for camping, fishing, and water sports of all kinds. An hour's drive from Palisades brings the traveler to Idaho Falls, where the Eastern Idaho State Fair is held each year during the latter part of August; the War Bonnet Roundup, in late June; and the

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Campers enjoy Banks Lake, Columbia Basin Project, Washington.

WATER REPORT

Forecasts of the 1961 water supply conditions are based on March 1 snow surveys and a survey of changes in mountain snowpack to March 15, by the U.S. Department of Agriculture, Soil Conservation Service and many cooperating organizations,[1] on over 1400 snow courses and 100 soil moisture stations. Further snow surveys were to be made on April 1 and later dates to measure the final snow accumulation. In addition, other basic data, including streamflow and precipitation, are used in preparing streamflow forecasts. Storage in reservoirs, and soil moisture in irrigated areas is considered in water supply outlook.

For the third year in succession extremely deficient streamflow is forecast for the snowmelt season over a wide area of Utah and Nevada, southern Wyoming and Idaho, southeastern Oregon and the Central Valley of California. The water shortage is most critical in Nevada and parts of Utah and California where total water supply ranges from one-half to less than one-quarter of normal. Holdover storage built up three or more years ago has been gradually depleted and is now practically exhausted.

Only in the northern section of the Columbia Basin and coastal areas of the Northwest is near normal streamflow in prospect. Elsewhere water shortage will be general with streamflow forecasts from one-half to three-quarters of normal.

As for the past 2 years, irrigated lands along the smaller or tributary streams without carryover storage will be most affected by the lower water supply conditions. Even on large streams, storage carryover is generally much less than average.

This series of low water years points to the need for the most efficient use of irrigation water and to limit crop acreages or demand to that for which water supply will be available. It is usually more profitable to provide adequate irrigation water to a limited acreage than to

by HOMER J. STOCKWELL, Staff Assistant, Water Supply Forecast Unit, Soil Conservation Service, Portland, Oregon

[1] The Soil Conservation Service coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, and Geological Survey, other Federal Bureaus, various departments of the several states, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that state, contributed for California figures appearing in this article.

spread a short water supply over all land normally in crops.

Information for this report was supplied by the snow survey supervisors, Soil Conservation Service for all states except California, from which data was supplied by the Department of Water Resources. Information was assembled under the supervision of R. A. Work, Head, Water Supply Forecast Unit, Soil Conservation Service.

In this article it is not possible to report detailed water supply conditions for local areas. With the widespread shortage of water expected this year, water users should check with irrigation company management, state water officials, and others who have exact information on water supply outlook for individual streams. Brief, but complete reports are available for small watershead areas from State and local offices of the Soil Conservation Service and State Departments of Water Resources.

In the following paragraphs the outlook by States is briefly reviewed.

ARIZONA: Water supply outlook for Salt River Project is good due to above normal storage carried over from last year. For remainder of State, the outlook is poor. San Carlos Reservoir is almost empty. Streamflow from snowmelt will be much below normal. Snowpack as of March 1 is one-half of normal or less except at highest elevations. Precipitation in recent months follows a similar pattern.

CALIFORNIA: California Department of Water Resources, coordinating agency for California Cooperative Snow Survey Program, reports:

Water conditions in most areas of California will be the most critical since 1931. In San Joaquin Valley there is good chance runoff this year will be comparable to that of 1924, driest of record. Only in Upper Sacramento Valley and in North Coastal areas will water supplies be near normal. Unless precipitation is far above average for remainder of season, serious shortages of irrigation water may be expected throughout most of State.

Even where municipal water supplies are concerned, shortage may be expected where carryover is inadequate and imported supplies are not available.

This third consecutive year of below average surface runoff will put increased demands upon groundwater basins, resulting in further lowering of groundwater levels. Precipitation for season to date (October 1, 1960 to March 1, 1961) has been near normal in northern portion of State. However, seasonal precipitation follows a general pattern of increasing deficiencies from north to south.

In much of southern California, this season is one of driest of record. Seasonal precipitation in important water producing areas of Sierra-Nevada has been about 65 percent of normal, except for upper Sacramento River Basin which has received about 95 percent of normal. It would require March and April precipitation greater than maximum of record to achieve normal runoff in most areas of State. There is only about one chance in 25 that precipitation for remainder of year will be heavy enough to give average runoff on statewide basis.

South of Sacramento latitude, chances for average runoff are much less. Even with normal precipitation for remainder of season, runoff in area south of Sacramento will be near record low.

COLORADO: Snowfall over Colorado has been deficient through winter months. Storms in early March resulted in some improvement but total snow accumulation to date is still considerably less than normal. Soils under snow are dry except for an isolated area on the Sangre de Cristo range. Streamflows are forecast in range of 50 to 80 percent of normal. This will result in rather substantial shortages of water on Rio Grande and Arkansas, and Dolores and other smaller tributaries of Colorado River, particularly in southwest section of State.

Shortage on South Platte watershed will be alleviated somewhat due to carryover storage in the Colorado-Big Thompson where this supplemental water is available. Storage in Denver city reservoirs is adequate.

IDAHO: Snowfall during February was near normal in all but southern part of state. Total seasonal snowpack remains considerably below average except for northern portion on tributaries flowing directly into Columbia River.

All rivers flowing north and south into Snake, including Big and Little Wood rivers, Big and Little Lost rivers, Malad River, Raft River, Salmon Falls Creek, all desert streams in Owyhee County, and Owyhee River are expected to be critically short of water this year to meet normal demands. Substantial adjustments in crop acreage will have to be made.

Main stem of Snake, Boise, and Payette can deliver almost normal supplies by use of reservoir storage.

KANSAS: As far as snowmelt water is concerned, water supply outlook for Arkansas River in western Kansas is poor. Storage in John Martin Reservoir is only 15,000 acre-feet and inflow from snowmelt will probably be less than half of average. Spring storms on plains could improve outlook.

MONTANA: Water supply outlook west of Continental Divide in Montana is relatively good. Streamflow will be generally slightly less than normal. Late irrigation water is expected to be limited in Upper Clark Fork and Blackfoot basins and in Bitterroot River, where storage is not available. On Missouri River tributaries, shortages will be more common but not as severe as for southwestern states. Most streamflow forecasts range from 50 to 70 percent of normal. Prospects for downstream flow of Missouri and Yellowstone rivers tend to be less. Shortages will be more extensive in late season where storage is not available than on west side of Divide.

NEBRASKA: Inflow to large reservoirs in Wyoming will be about 60 percent of normal, probably less than last year. With carryover storage depleted, water supply in sight will not be adequate to meet normal demands along North Platte in western Nebraska this year. Outlook is the poorest for over 20 years. On Republican River, carryover storage equals or exceeds irrigation pool capacity. Water supply along this stream will be adequate.

NEVADA: As of March 1 surface water supply outlook for all irrigated areas of Nevada will approach most severe shortage of record, less than for the past two drouth years. Forecasts of streamflow are only one-quarter to one-third of normal for principal irrigated area. Storage in Lake Tahoe is only 30 percent of normal. Other reservoirs throughout State have almost negligible storage, averaging near one-tenth of normal. There is practically no possibility of improvement in outlook for this year.

NEW MEXICO: Again this year irrigated area along Rio Grande in New Mexico has a below normal water supply in prospect. Storage is about half past 15-year normal and 200,000 acre-feet less than for a year ago. Flow of Rio Grande is forecast at near one-half of normal. Total outlook is comparable to many drouth years that have occurred during the past 10 years, but poorer and less than for last year.

Outlook for irrigated areas along the Pecos and Canadian rivers is good for 1961. Reservoirs are at or near capacity as result of heavy rains last fall. Soil moisture conditions are relatively good in irrigated areas.

In northwest New Mexico flow of San Juan and tributaries will be near one-half of normal, but adequate to meet all but late season water requirements.

OREGON: Outlook for Oregon remains far below normal and actually decreased during February even if rainfall was heavy west of Cascades. Shorter water supplies than were available for last year are expected for many areas. Reservoir storage, which includes carryover from 1960, improved during February but remains inadequate for most irrigated areas outside the Willamette Valley. March 1 snowpack is actually only one-half of normal with

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maintenance of drains

Maintenance of disposal channels (drains and wasteways) has been most often limited to correctional procedures. In other words, a channel was constructed according to the best engineering principles available; it was operated according to the best practices known to the manager; and at some time before the channel became so deteriorated it could no longer function, it was cleaned or otherwise rehabilitated.

Preventive maintenance, however, is in the old spirit of "A stitch in time . . ." A successful preventive maintenance procedure is one developed on the Bureau of Reclamation's Columbia Basin project, Washington, by O. A. Mowery. The preventive maintenance offers full-season troublefree operation, rather than a gradual reduction of the channel capacity. Costs of maintenance and of operation are reduced, beginning with the first year.

The success of the maintenance operation requires an adequate supply of water to carry sand, silt, and fine debris downstream. More water is turned into the channel if the initial flow is too low. Extremely heavy grass berms or intrusions may require trimming by ditcher blade or other means before the drag bucket procedures can be started.

Drag bucket drain maintenance requires access or roadways on both sides of the channel. As shown in the accompanying photograph a truck-mounted dragline operating on one side of the channel is employed to jointly pull a special lightweight open-web bucket, and to dump the bucket as it becomes full of debris. A crawler tractor with cable winch is used on the opposite bank to pull and to keep the bucket alined in the channel. The bucket is designed to very nearly fit the bottom of the channel. The square teeth are set to hold the bucket steady, yet not dig excessively into the channel.

The effect of a first pass through a channel is to clean off most sandbars, to straighten beginning meanders and to cut a light channel through sloughed deposits. During this first pass, cattails and tall green weeds are pressed against the banks, and dry weeds are accumulated and lifted out as necessary. One or two additional passes may be required if bars or meandering are beyond the beginning stage.

In the photograph, looking downstream, the drag bucket is moving upstream, cleaning the drain after one pass had been made in heavy cat-

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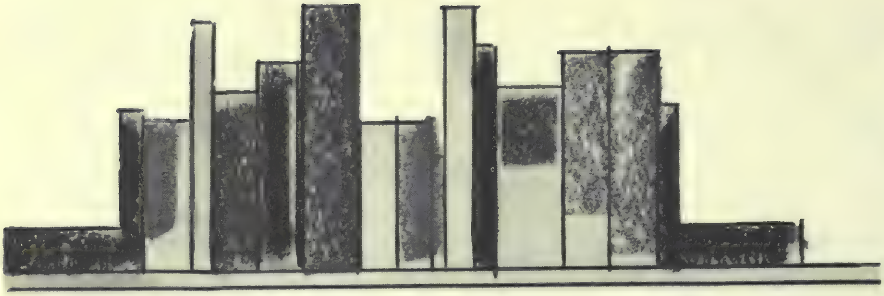
Reprinted from the Bureau of Reclamation's "Operation and Maintenance Equipment and Procedures Release No. 34," prepared by the Division of Irrigation Operations, Denver, Colorado.



BOOKSHELF for water users

Many Bureau of Reclamation publications, technical and nontechnical, are now available in newer and better editions than some that are still in use among water users, and some new titles have been published.

Among the relatively new publications is *Irrigation on Western Farms.* This 53-page booklet, prepared jointly by the Bureau of Reclamation and the Soil Conservation Service, U.S. Department of Agriculture, supersedes *Farmer's Irrigation Guide* and *Practical Irrigation.* It covers methods of irrigation and practices to improve the soil-water-plant relationship through better management for a more profitable and permanent agriculture.

Design of Small Dams (1960) is one of the latest of the Bureau's technical books. Three others are *Earth Manual* (1960), *Paint Manual* (expected soon), and *Reclamation Project Data.*

Design of Small Dams is addressed principally to community leaders who contemplate dam construction and to engineers who may plan such facilities. This is a technical book intended to serve primarily as a guide to safe practices for those concerned with the design of small dams in public works programs in the United States.

Reclamation's Recreational Opportunities, recently updated, is a folder addressed to persons who may wish to vacation at the parklike areas adjacent to Reclamation reservoirs. This folder includes a map and table showing the location of specific recreational areas and a description of the facilities available at each.

A representative list of relatively recent Bureau publications including those that are referred to above follows: (Titles for which no price is given are available free.)

Nontechnical

- Glen Canyon Dam (Arizona)
- Hoover Dam (Arizona-Nevada)
- Grand Coulee Dam and Powerplant (Washington)
- Central Valley Project (California)
- Hungry Horse Dam (Montana)
- Columbia Basin Project (Washington)
- Colorado River Storage Project and Participating Projects
- Reclamation's Recreational Opportunities (15¢)
- Engineering Careers in Reclamation (of interest to graduates in engineering who may wish to specialize as reclamation engineers with the Bureau)

Technical

- Design of Small Dams (1960) ($6.50)
- Earth Manual (1960) ($3.75)
- Paint Manual (1961) (not yet priced)
- Reclamation Project Data ($6.75) (a comprehensive fact book about Reclamation)

For a complete list of available Bureau publications, free, and for sale, address: Bureau of Reclamation, attention 841, Building 53, Denver Federal Center, Denver 25, Colo. # # #

Reclamation's Economic Impact

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Rock salt protects perishable produce. Many Reclamation projects ship fruit and vegetables even during winter.

agricultural surpluses are a problem?

Contrary to popular belief, farm surpluses are confined to a small number of crops. Wheat, corn, cotton, grain sorghum, and tobacco comprise 95 percent of the surplus crop holdings of the Commodity Credit Corporation. Reclamation farms grow no tobacco. Cotton supply and demand has now adjusted to the point where an increased acreage of cotton plantings was called for this year.

Wheat is the Nation's number one surplus crop, comprising two-fifths of the above mentioned CCC inventory. When irrigation is introduced into the dryland wheat country, farm enterprises diversify and wheat growing is replaced by more stable and profitable crops. A very small amount of wheat is grown on Reclamation farms. It has little, if any, impact on the cash wheat market or on the commercial wheat supply because it is utilized for poultry and livestock feed right on the irrigated farms.

Reclamation farms grew about one percent each of the country's corn and sorghum crops in 1959. The corn and sorghum grown under irrigation in the West therefore cannot compete to any significant degree with the 99 percent grown elsewhere. This one percent does not enter the market channels since it is urgently needed on the irrigated farms and surrounding ranches for supplemental feed. The enhancement of the 700 million acres of western rangeland through the availability of irrigated feed crops is of incalculable value to the country's livestock industry. Distance alone precludes midwestern farms from being feasible alternative sources of supplemental feed in most of these range areas.

By and large the crops produced under irrigation in the West are those which enjoy ready markets and increasing demand. Irrigation enables farmers to be highly versatile and they shift production to meet market conditions. Irrigation's contribution to our high nutritional standard through production of fresh fruits and vegetables and livestock products is well known.

The whole Reclamation story would fill a book. The complete treatment would include the success story of project repayment by the water users. It would relate the millions in wealth and income saved by averaging out droughts and floods. It would illustrate the strategic role of hydroelectric power in national defense. It would point out the vital importance of our projects in the production of sugar. It would show the tremendous return of taxes to the Federal Treasury from the results of Reclamation development. It would chart the country's need, even now as inevitably in the future, for new employment and business opportunities, new food and fiber supplies, and new areas in which to live and enjoy nature. # # #

Maintenance of Drains

Continued from page 47

tail growth and through an area where the banks had sloughed the previous year.

With a pilot channel made to conform to the proper alinement of the drain, the water flowing in the drain then performs most of the additional work. Excessive deposited materials are laid up on the slopes in thin rolls which readily "melt" into the flowing water. Further downstream the materials are deposited as a fairly uniform layer.

Grasses seeded for waterline protection and weed control may be temporarily covered with a thin layer of soil; however, recovery occurs within a few weeks. Cattails bent sharply during the operation appear to be retarded, the density of stands greatly reduced. On this project, willows had been previously controlled with 2,4–D.

The drag bucket method of cleaning of drains and wasteways has been effective on a new disposal system which lies in sandy soils. It is expected that heavy cleaning will not be required so often as the system becomes older. Costs of cleaning by the drag bucket method ranged from \$40 to \$70 per lineal mile, compared with \$125 to \$500 per lineal mile by conventional methods. # # #

Interior's New Team
Continued from page 32

rich foods. Electric energy in adequate supply at a reasonable cost is basic to an expanding industrial economy.

"If we are to provide abundant power and water resources for future generations on a reasonable basis, we must plan and act now. I believe that our God-given resources were created for the good of all the people. The Federal Government's responsibility to make certain that they are used and developed for the good of all of the people is basic to a free society. To meet the challenges of the future, all segments of our economy must work together to this end."

Prior to appointment as Under Secretary, Mr. Carr, whose home is Sacramento, Calif., was assistant general manager of the Sacramento Municipal Utility District for 8 years. From April 1951 to June 1953, he was engineering consultant to the House Interior and Insular Affairs Committee, working primarily on irrigation and reclamation matters; and for the preceding 15 years, he was a career employee of the Department of the Interior and the Bureau of Reclamation.

In accepting his present position, Mr. Carr expressed his feeling about Federal service in a telegram to President Kennedy, saying, "It will be a pleasure to again serve with many dedicated Department employees I have known from more than 15 years prior service with the Department of the Interior."

With Interior, Mr. Carr rose progressively through the career ranks, serving in positions of increasing responsibility. As an engineer and administrator with the Bureau of Reclamation, he served on the planning, construction, and operation of Shasta Dam, Keswick Dam, and the Orland project. He participated in studies on the Trinity and Feather River projects from 1946 to 1951, and, as district manager, he directed all activities of the Bureau of Reclamation in northern California, under the regional director.

Before embarking on the 15 years of career service mentioned above, Mr. Carr served with the Department's Geological Survey, Topographic Division, for three separate survey seasons. His first job with the Department was with a survey crew of the Geological Survey at Mt. Lassen, Calif., in 1933 during the summer.

He attended public schools in Redding, Calif., and was graduated from the University of Santa Clara with a bachelor of science degree in civil engineering in 1934. He is a registered professional engineer in California and the District of Columbia, and is a Fellow, American Society of Civil Engineers, and a member of the Board of Regents, University of Santa Clara.

He is married to the former Katherine Kergan of Piedmont, Calif. They have four daughters, Mary, Ann, Susan, and Margaret.

Mr. Holum, prior to his appointment, managed and operated a farm near Groton, S. Dak., since 1933 and was executive director of the Midwest Electric Consumers Association.

In addition he has been chairman of the Western States Water and Power Conference (1956–1961); vice president, Northern Electric Cooperative (REA) (1948–1960); president, James Valley Cooperative Telephone Association (1952–1960); president, South Dakota Rural Telephone Association (1954–1960); and executive secretary, South Dakota Association of Cooperatives (1957–1961).

Mr. Holum also served as vice president of the Northern Electric Cooperative in 1957 and was secretary of the East River Electric Power Cooperative (REA) from 1950 to 1954. He also has been supervisor, South Brown Soil Conservation District and vice chairman of the South Dakota Association of School Boards. He was appointed a member of the Missouri Basin Survey Commission by President Truman in 1951, serving on that body for 2 years. From 1949 through 1953, he was a member of the South Dakota Legislature.

Mr. Holum attended public schools in Brown County, S. Dak., and was graduated from Augustana College in 1936 with a bachelor of arts degree. His wife is the former Solveig Myrwang of Baltic, S. Dak. They have six children, Margaret, Kenneth, Jr., John, Robert, Charles, and Knute. # # #

Water-loving and generally worthless vegetation (phreatophytic and hydrophytic plants) along western streams cover nearly 16 million acres in their entirety and are expanding rapidly. This vegetation may discharge from 20 million to 25 million acre-feet of water into the atmosphere annually. Salvage of even a small part of this water could have a marked and appreciable effect on the water economy in the Western States.—Senate Select Committee on National Water Resources.

Recreation at Man-Made-Lakes
Continued from page 44

Pioneer Rodeo, on July 24. With a one-and-a-half hour drive from Idaho Falls, the visitor can see one of the most spectacular displays of geologically recent volcanic activity in America at the Craters of the Moon National Monument.

Going west down the Snake River, the traveler will pass through desert interspersed with miles of green irrigated fields of potatoes, sugar beets and beans. The Upper Snake River Valley is one of the most productive and successfully irrigated farming areas in the world.

The traveler then arrives in the beautiful irrigated Boise Valley—gateway to rugged and spectacular central Idaho.

Within a few hours, visits can be made to Cascade Lake on the Payette River; Arrowrock and Lucky Peak reservoirs on Boise River; Payette Lakes recreational area; and the renowned Hells Canyon of the Snake River. For the cowboy enthusiasts, the "Snake River Stampede" and the Caldwell "Night Rodeo"—major rodeo attractions—are held each summer in Nampa and Caldwell, Idaho. The Western Idaho State Fair, during late August at Boise, offers further diversion for the visitor.

Across the Oregon border lies Owyhee Reservoir, behind a spectacular concrete, gravity-arch dam which rises 417 feet from the streambed of the Owyhee River.

The reservoir—featuring some of the best crappie and bass fishing anywhere—is in a deep canyon, and tremendous multicolored rock cliffs rise on every side. Ancient Indian writings are to be found on rocks in several areas. The Oregon State Park Commission has developed two popular park areas with camping and boat facilities.

Owyhee Reservoir provides water storage for the irrigation of some 118,000 fertile acres in the valley below. Project lands are famous for gamebirds and waterfowl hunting.

A major stop on the scenic journey toward the Pacific coast would be Spokane—hub of the Pacific Northwest's inland empire—with its Spring Lilac Festival. From here, it is only a 2-hour drive to one of the civil engineering wonders of the world—Grand Coulee Dam spanning the mighty Columbia River.

Also from this point, it is another short distance into Montana through Idaho's narrow, forested panhandle to the Bureau's Hungry Horse Dam and reservoir, with Glacier National Park and Lake McDonald nearby.

On the South Fork of the Flathead River, Hungry Horse Dam, a graceful concrete gravity-arch structure, towers some 564 feet, making it one of the highest dams in the United States. Water cascades over the Glory Hole spillway to drop 490 feet to the river below the dam.

Hungry Horse Dam is in a setting of virgin timberland, and its reservoir is 34 miles long. Fishing is excellent, and magnificent stands of pine, larch and fir blanket the surrounding area.

Grand Coulee Dam, in Washington's Columbia Basin, is 4,173 feet long and 550 feet high and its spillway is half as wide and twice as high as Niagara Falls. In summer, thousands of tons of water pour over this spillway in an awesome display. For even greater enjoyment of the visitor, the spillway waterfall is lighted each night in a glorious display of color.

The Coulee Dam National Recreation area, administered by the National Park Service, offers outstanding vacation opportunities. Camping facilities are available at a number of marinas along the 151-mile-long Franklin D. Roosevelt Lake.

Buffalo Bill Dam, on highway to east entrance of Yellowstone Park, has made Shoshone Canyon useful, as well as beautiful.

Recreation at Canyon Ferry Reservoir, Montana, is important auxiliary benefit of this irrigation development on Missouri River.

Every Memorial Day holiday, the area surrounding Grand Coulee Dam holds a Colorama, featuring the first lighting of the spillway for the year.

The visitor to Grand Coulee should also plan to visit the panorama of newly irrigated farmlands of the Columbia Basin project. Other sights to see in the area include Chief Joseph, Priest Rapids, and Rocky Reach dams on the Columbia River. The city of Wenatchee, nearby, holds an annual springtime Apple Blossom Festival.

In the heart of the State of Washington are the half million irrigated acres of the Yakima project. Rimrock Lake behind Tieton Dam, one of the six scenic irrigation reservoirs serving the project, is only a short drive from the city of Yakima. The new ski chairlift at White Pass, across the Cascade Mountains is a favorite both in winter and summer; and no visitor should miss a trip to old Fort Simcoe, a century old relic of the Indian wars, only a 45-minute drive from Yakima.

If the vacationist is in this area about Labor Day, a trip should be planned up the Yakima River Canyon to Ellensburg to watch the Ellensburg Rodeo.

From this area, it is only a short drive across the Cascade Mountains to Seattle and Puget Sound, scene of the annual summer "Seafair Festival."

Of course, the vast majority of Bureau of Reclamation reservoirs offering recreation opportunities—and the surrounding areas—have not been mentioned here. However, a list of these reservoirs, entitled "Reclamation's Recreational Opportunities," is now available. (See Bookshelf for Water Users, this issue.). # # #

Next issue: Recreation at Man-Made Lakes—Part II.

The Water's Fine IF!

Continued from page 35

tees will have the benefit of a nationwide coordinated source of material and information to help them put across water safety programs on a local level.

The Recreational Boating and Water Safety Section is a part of the Public Safety Department of the National Safety Council in the same way as Traffic, Industrial and Home Safety. This gives national recognition to the problem.

There are Red Cross and Bureau of Reclamation representatives on this national committee.

As this story was being prepared, the writer was informed that the Yakima Valley Water Safety Committee had been chosen the winner of the annual National Gold Cup Award for Community Effort in Boating and Water Safety, granted each year by the Kiekhaefer Corporation. The panel of judges includes such distinguished boating leaders as Don Guerin, chairman, Special Events, American Power Boat Association; Rear Adm. H. T. Jewell, chief, Office of Merchant Marine Safety, U.S. Coast Guard; Webb Sheehy, past national Commodore, U.S. Coast Guard Auxiliary; Charles Sligh, chairman of the board, American Water Ski Association; and William Wolfmuller, past chief Commander, United States Power Squadrons. There are two other categories in this contest, an individual award, and one for news media promoting such a program. This award will do much to create added incentive toward greater effort on behalf of water safety. As one citizen said on hearing of the award, "Imagine—our community way up here in the Pacific Northwest winning national recognition. I know we can do more yet."

The national theme is "Everyone Learn to Swim." Then and only then can we really enjoy the invitation "Come on in—the water's fine."

# # #

Why not make water safety in your community a service project for this year? The Bureau of Reclamation will join in community water safety programs as a consultant, and many of its trained personnel will gladly participate as individuals.

Water Report

Continued from page 46

only a small part of the snow accumulation season remaining.

Most critical water situations in Oregon are streams flowing into Ochoco, Drew, Owyhee, McKay, Hyatt, Clear Lake, and Gerber reservoirs, and flow of Crooked and Silvies rivers. Seasonal flow for all these streams is forecast at less than one-half of normal.

TEXAS: Storage in Elephant Butte and Caballo reservoirs in New Mexico totals 500,000 acre-feet, about 60 percent of normal and 200,000 acre-feet below March 1, 1960. Inflow to Elephant Butte is forecast at 200,000 acre-feet for March through July. Water supply for Rio Grande area of west Texas will be substantially less than average and last year, but better than for drouth years of mid 1950's. About average water supply is in sight along the Pecos River.

UTAH: For most of Utah, water supply outlook is poorest of record, comparable to 1934. Streamflows in most favored areas are forecast at two-thirds to three-quarters of normal. These include streams with high elevation watersheds near east end of the Uintah Basin, Logan River, and near Salt Lake City and Farmington. Streams with low watersheds will have flows as low as one-quarter of normal even in these areas. Forecasts for all other streams range from 25 to 60 percent of normal for summer season.

To add to poor water picture, storage of water in principal reservoirs of state is about one-half of normal for this date. Major exception is Bear Lake, which has near normal storage for irrigation but this storage will only alleviate to some extent the shortage of streamflow.

Snow surveys and other data show that water supplies will be critically short in all of State, but there is substantial variation in shortage among irrigated areas. Water users should check closely on status of their individual water supply.

WASHINGTON: State of Washington is the one bright water supply situation among all of western states. In major irrigated areas, supply normally exceeds demands. Streamflow forecasts range for 80 to 100 percent of normal. Irrigation reservoirs which are not full will fill during the snowmelt season runoff.

WYOMING: Substantial shortage in water supply for 1961 in Wyoming is in prospect although there is some opportunity for improvement after March 1. If so, snowfall at high elevations would have to be considerably above average during March, April, and early May to provide adequate, if below normal water supply. Streamflow forecasts range from about 60 percent of normal for North Platte and upper Bighorn River tributaries to 80 percent for upper Missouri. Bear River watershed in the extreme southwest part of state shares extreme shortage of Utah watersheds.

Combination of depleted reservoir storage and expected low streamflow will provide lowest total water supply along North Platte in eastern Wyoming and western Nebraska in about 20 years.

Small tributaries to Bighorn River without storage will be short again this year, comparable to 1960.

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Water stored in western reservoirs

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	March 31, 1960	March 31, 1961
Region 1	Baker	Thief Valley	17, 400	17, 400	17, 000
	Bitter Root	Lake Como	34, 800	20, 100	10, 000
	Boise	Anderson Ranch	423, 200	324, 400	145, 000
		Arrowrock	286, 600	274, 500	286, 600
		Cascade	654, 100	443, 200	262, 000
		Deadwood	161, 900	84, 500	55, 000
		Lake Lowell	169, 000	142, 200	139, 000
		Lucky Peak	278, 200	229, 800	105, 000
	Burnt River	Unity	25, 200	17, 800	19, 000
	Columbia Basin	F. D. Roosevelt Lake	5, 072, 000	2, 724, 000	2, 551, 000
		Banks Lake	761, 800	536, 600	562, 000
		Potholes	470, 000	268, 800	272, 000
	Deschutes	Crane Prairie	55, 300	2, 800	41, 000
		Wickiup	187, 300	183, 000	181, 000
	Hungry Horse	Hungry Horse	2, 982, 000	2, 395, 000	2, 318, 000
	Minidoka	American Falls	1, 700, 000	1, 616, 200	1, 504, 000
		Grassy Lake	15, 200	11, 900	7, 000
		Island Park	127, 200	127, 200	109, 000
		Jackson Lake	847, 000	478, 400	134, 000
		Lake Walcott	95, 200	87, 200	79, 000
	Ochoco	Ochoco	47, 500	12, 700	20, 000
	Okanogan	Conconully	13, 000	9, 100	6, 000
		Salmon Lake	10, 500	10, 100	9, 000
	Owyhee	Owyhee	715, 000	464, 200	322, 000
	Palisades	Palisades	1, 202, 000	876, 000	637, 000
	Umatilla	Cold Springs	50, 000	50, 000	50, 000
		McKay	73, 800	43, 100	54, 000
	Vale	Agency Valley	60, 000	36, 400	34, 000
		Warm Springs	191, 000	92, 000	51, 000
	Yakima	Bumping Lake	33, 700	14, 300	17, 000
		Clear Creek	5, 300	5, 300	5, 000
		Cle Elum	436, 900	325, 800	315, 000
		Kachess	239, 000	203, 700	181, 000
		Keechelus	157, 800	108, 900	101, 000
		Rimrock Lake	198, 000	176, 100	151, 000
Region 2	Cachuma	Cachuma	201, 800	178, 100	153, 530
	Central Valley	Folsom [1]	920, 300	612, 200	440, 100
		Jenkinson Lake	40, 600	40, 600	23, 450
		Keswick	20, 000	17, 800	18, 790
		Lake Natoma	8, 800	8, 500	2, 260
		Millerton Lake	427, 800	128, 100	126, 000
		Shasta Lake	3, 998, 000	3, 393, 500	3, 095, 300
		Lake Thomas A. Edison	125, 100	37, 600	(2)
	Humboldt	Rye Patch	190, 000	27, 800	13, 252
	Klamath	Clear Lake	513, 300	182, 400	121, 660
		Gerber	94, 300	25, 000	20, 000
		Upper Klamath Lake	524, 800	393, 200	443, 900
	Newlands	Lahontan	290, 900	(2)	106, 395
		Lake Tahoe	732, 000	(2)	106, 800

See footnotes at end of table.

Water stored in western reservoirs—Continued

(Operated by Bureau of Reclamation or Water Users except as noted)

Location	Project	Reservoir	Active storage (in acre-feet)		
			Active capacity	March 31, 1960	March 31, 1961
	Orland	East Park	50,600	50,600	50,920
		Stony Gorge	50,000	50,000	50,000
	Truckee Storage	Boca	40,900	22,200	10,641
Region 3	Boulder Canyon	Lake Mead	27,207,000	19,171,000	18,212,000
	Parker-Davis	Havasu Lake	619,400	546,300	566,700
		Lake Mohave	1,809,800	1,568,200	1,683,700
	Salt River	Apache Lake	245,100	235,000	214,640
		Bartlett	179,500	145,000	29,472
		Canyon Lake	57,900	57,900	45,341
		Horseshoe	142,800	76,000	16,324
		Theodore Roosevelt Lake	1,381,600	1,022,000	816,938
		Sahuaro Lake	69,800	66,000	63,196
Region 4	Eden	Big Sandy	38,300	4,500	5,510
	Fruitgrowers Dam	Fruitgrowers	4,500	2,400	1,698
	Hyrum	Hyrum	15,300	12,900	14,600
	Mancos	Jackson Gulch	9,800	1,600	3,180
	Moon Lake	Midview	5,800	5,700	5,800
		Moon Lake	35,800	12,400	11,400
	Newton	Newton	5,400	3,100	1,700
	Ogden River	Pineview	110,200	30,400	16,200
	Pine River	Vallecito	126,300	44,300	44,400
	Provo River	Deer Creek	149,700	76,900	63,300
	Scofield	Scofield	65,800	8,000	3,400
	Strawberry Valley	Strawberry Valley	270,000	109,600	59,000
	Uncompahgre	Taylor Park	106,200	49,900	34,070
	Weber River	Echo	73,900	41,100	34,500
Region 5	W. C. Austin	Altus	162,000	139,800	140,700
	Balmorhea	Lower Parks	6,500	5,000	5,200
	Carlsbad	Alamogordo	122,100	97,700	122,100
		Avalon	6,000	1,100	1,815
		McMillan	32,300	20,700	25,050
	Colorado River	Marshall Ford	1,837,100	761,900	749,500
	Middle Rio Grande	El Vado	194,500	14,300	8,580
	Rio Grande	Caballo	340,900	91,200	85,480
		Elephant Butte	2,185,400	554,600	346,300
	San Luis Valley	Platoro	60,000	4,000	4,000
	Tucumcari	Conchas [1]	467,300	228,200	279,397
	Vermejo	Reservoir No. 2	2,900	1,400	1,150
		Reservoir No. 13	5,000	4,800	4,800
		Stubblefield	16,100	6,200	5,620
Region 6	Missouri River	Angostura	92,000	28,800	6,500
		Boysen	710,000	139,600	106,300
		Canyon Ferry	1,615,000	1,509,700	1,078,300
		Dickinson	13,500	5,900	4,100
		Fort Randall	4,900,000	3,220,000	2,607,000
		Garrison [1]	18,100,000	5,020,000	4,741,900
		Lake Tschida	218,700	75,100	49,800
		Jamestown	39,200	10,400	15,900
		Keyhole	190,300	14,800	2,700
		Lewis and Clark Lake	385,000	385,000	259,200
		Pactola	55,000	25,400	16,400
		Shadehill	300,000	82,400	51,300
		Tiber	762,000	116,900	94,000
	Belle Fourche	Belle Fourche	185,200	60,900	37,600
	Fort Peck	Fort Peck [1]	14,389,000	6,860,800	6,684,400
	Milk River	Fresno	127,200	127,200	34,100
		Nelson	66,800	50,200	39,500
		Sherburne Lake	66,100	21,300	22,200
	Rapid Valley	Deerfield	15,100	1,700	2,800
	Riverton	Bull Lake	152,000	36,600	58,300
		Pilot Butte	31,600	26,000	24,700
	Shoshone	Buffalo Bill	380,300	128,000	135,200
	Sun River	Gibson	105,000	79,500	38,600
		Pishkun	30,100	21,600	16,700
		Willow Creek	32,400	18,500	19,900
Region 7	Colo.-Big Thompson	Carter Lake	108,900	80,000	85,619
		Granby	465,600	216,400	224,142
		Green Mountain	146,900	57,600	60,165
		Horsetooth	141,800	107,400	112,154
		Shadow Mountain	18,400	----	16,568
		Willow Creek	9,100	3,100	6,475
	Missouri River Basin	Bonny	167,200	45,000	35,970
		Cedar Bluff	363,200	206,600	163,510
		Enders	66,000	43,600	36,490
		Glendo	786,300	380,400	278,380
		Harlan County [1]	752,800	380,300	259,514
		Harry Strunk Lake	85,600	43,100	31,810
		Kirwin	304,800	95,400	75,420
		Kortes	4,500	[2]	4,290
		Lovewell	87,800	36,100	24,430
		Swanson Lake	249,800	136,800	101,620
		Webster	257,400	87,200	67,885
	Kendrick	Alcova	24,500	28,000	12,320
		Seminoe	957,000	252,400	63,300
	Mirage Flats	Box Butte	30,400	27,100	17,277
	North Platte	Guernsey	39,800	32,500	19,200
		Lake Alice	11,200	4,800	7,460
		Lake Minatare	59,200	30,300	17,990
		Pathfinder	1,010,900	277,400	251,730
Alaska Dist	Eklutna	Eklutna Lake	160,000	71,400	52,500

[1] Corps of Engineers Reservoir.
[2] Not reported.

Port of Call
Continued from page 40

Many visitors are interested in operation and maintenance problems and methods. Fortunately, we have several examples of different approaches to this subject, and often call on local farmers or officials of the Weber Basin Water Conservancy District, the Ogden River Water Users' Association, and the Weber River Water Users' Association to help when the visitor is especially interested in operating methods.

Meeting people from all over the world is not only interesting but enlightening. Each visitor is different, but acquaintance proves that these differences are more individual than national in origin. They like to talk about all the various subjects that interest people anywhere. The long rides between the scattered features of the Weber Basin project afford an opportunity for the visitor and his guide to forget about official business for a while and to get acquainted. Often it is possible to extend this personal contact beyond normal working hours, and sometimes visits can be arranged to schools, clubs, churches, etc. The overall value of the foreign-visitor program is not limited to the sharing of technical information. # # #

Kemal Ertunc of Turkey notes test pumping of well on Weber Project.

The People's Choice
Continued from page 38

On a windy Sunday afternoon, just a few days before the election, at an open house held at the Sanford damsite, 5,000 citizens came to see for themselves where the axis of the proposed dam would rest, where the spillway would be—they came to see what they were being asked to pay for. Young fathers held their small sons and asked about the rate of interest. Old men wanted to know how many years it would take to build the dam and store water. They looked out across the channel of the Canadian and listened to the technicians who were there with explanations and answers to their questions.

And when it was time, they went to the polls, and they made their own choice. # # #

United States Department of the Interior

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Bureau of Reclamation, Floyd E. Dominy, Commissioner

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REGIONAL OFFICES

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REGION 7: John N. Spencer, Regional Director, Building 46, Denver Federal Center, Denver, Colo.

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5405	Central Valley, Calif.	Jan. 18	Construction of earthwork, pipe lines, and structures for El Dorado main, laterals, and reservoirs for El Dorado distribution system, Schedule 2.	Piombo Construction Co., San Carlos, Calif.	$1,327,490
DC-5431	Missouri River Basin, S. Dak.	Jan. 5	Constructing foundations and erecting steel towers for single-circuit transmission line approaches to Oahe and Fort Randall switchyards.	Midland Constructors, Inc., Chicago, Ill.	331,558
DC-5432	Middle Rio Grande, N. Mex.	Jan. 4	Channelization of the Rio Grande, Albuquerque area, Unit 1.	Materials, Inc., Albuquerque, N.Mex.	391,428
DS-5433	Colorado River Storage, Utah-Wyo.	Jan. 17	Furnishing and installing three 40,000-kva generators for Flaming Gorge powerplant.	Westinghouse Electric Corp., Denver, Colo.	1,477,516
DC-5434	Central Valley, Calif.	Jan. 12	Construction of Lewiston Dam	Gibbons and Reed Co., Salt Lake City, Utah.	2,410,542
DC-5437	Missouri River Basin, Kans.	Jan. 18	Construction of earthwork and structures for Cedar Bluff canal, Sta. (−)0+43.1 to 211+44.6.	Utility Contractors, Inc., Wichita, Kans.	594,897
DS-5440	Missouri River Basin, S. Dak.	Feb. 8	Three 230-kv power circuit breakers for Watertown substation (stages 08 and 09).	General Electric Co., Denver, Colo.	155,550
DS-5441	Missouri River Basin, Iowa.	Jan. 26	Four 161-kv power circuit breakers for Sioux City substation (stage 04 additions), Schedule 2.	Westinghouse Electric Corp., Denver, Colo.	128,825
DC-5444	Central Valley, Calif.	Jan. 18	Construction of earthwork and structures for concrete pipe lines, laterals, and two pumping plants for Madera distribution system, Part 1 extension.	Cherf Brothers, Inc. and Sandkay Contractors, Inc., Sacramento, Calif.	982,116
DC-5446	Missouri River Basin, N. Dak.	Feb. 1	Stringing conductors and overhead ground wires for 84 miles of Jamestown-Fargo 230-kv transmission line No. 2.	Crawford Electric Co., North Platte, Nebr.	827,103
DS-5447	Central Valley, Calif.	Mar. 9	Furnishing and installing two 83,333-kva generators for Spring Creek powerplant.	Allis-Chalmers Mfg. Co., Denver, Colo.	1,491,400
DS-5451	Missouri River Basin, Iowa.	Feb. 10	One 36,000/48,000/60,000-kva autotransformer with lightning arresters for Spencer substation (stage 01).	C. A. Parsons and Co., Ltd., Newcastle upon Tyne 6, England.	100,505
DC-5453	Missouri River Basin, N. Dak.	Feb. 16	Construction of stage 05 additions to Jamestown substation and construction of dispatchers building with utilities.	Gustav Hirsch Organization, Inc., Columbus, Ohio.	221,494
DC-5454	Missouri River Basin, S. Dak.	Feb. 6	Stringing conductors for second circuit additions for 336.86 miles of Fort Thompson-Huron-Watertown, Fort Randall-Sioux City, and Fort Randall-Fort Thompson 230-kv transmission lines.	Commonwealth Electric Co., Lincoln, Nebr.	3,096,520
DS-5455	Central Valley, Calif.	Feb. 16	Four 156-inch butterfly valves for Clear Creek and Spring Creek power plants.	Nordberg Mfg. Co., Milwaukee, Wis.	459,000
DS-5456	Central Valley, Calif.	Feb. 16	Two 158-inch butterfly valves for Trinity powerplant.	Nordberg Mfg. Co., Milwaukee, Wis.	292,500
DC-5457	Missouri River Basin, Iowa.	Mar. 8	Construction of 213 miles of Sioux City-Spencer and Sioux City-Denison-Creston 161-kv transmission lines.	Hoak Construction Co., West Des Moines, Iowa.	3,335,243
DC-5459	Missouri River Basin, Mont.	Feb. 2	Construction of streets, sidewalks, and water and sewerage systems, including a concrete pump house with equipment, for Yellowtail government community facilities.	COP Construction Co., Billings, Mont.	251,211
DC-5462	Missouri River Basin, Nebr.	Feb. 24	Construction of Merritt Dam and access road, utilizing soil cement on upstream slope, Parts A and C.	Bushman Construction Co., St. Joseph, Mo.	2,655,044
DC-5464	Central Utah, Utah	Mar. 7	Construction of earthwork and structures for Stanaker service canal.	A and B Construction Co., Helena Mont.	1,327,584
DC-5465	Collbran, Colo.	Feb. 24	Construction of 4.75 miles of Upper Molina-Lower Molina 115-kv transmission line, and 6.12 miles of Upper Molina, equalizing reservoir, and Bonham-Cottonwood 12.47-kv joint power and telephone lines.	Line Builders, Inc., Billings, Mont.	148,742
DC-5467	Missouri River Basin, Nebr.	Feb. 20	Construction of earthwork and structures for Farwell Main canal, Farwell Central canal, and laterals, wasteways, and drains.	Bushman Construction Co., St. Joseph, Mo.	1,935,856
DS-5469	Colorado River Storage, Ariz-Utah.	Mar. 23	Eight 13.96-foot by 22.45-foot fixed wheel gate frames and anchorages for penstock intakes at Glen Canyon Dam.	Rockwell Engineering Co., Blue Island, Ill.	309,500
DC-5470	Missouri River Basin, Nebr.	Mar. 6	Construction of concrete highway bridge and 10 concrete county bridges for Sherman feeder canal, using prestressed precast-concrete beams-spans, Parts A and B.	William Anderson Co., Inc., Holdrege, Nebr.	259,759
DC-5471	Missouri River Basin, Iowa.	Mar. 21	Two 30,000/40,000/50,000-kva autotransformers with lightning arresters for Denison substation (stage 01), Schedule 1.	General Electric Co., Denver, Colo.	194,039
DC-5475	Colorado River Storage, Utah-Colo.	Mar. 14	Construction of 85.2 miles of Flaming Gorge-Vernal-Rangely 138-kv transmission line.	Irby Construction Co., Jackson, Miss.	1,279,899
DC-5479	Missouri River Basin, S. Dak.	Mar. 17	Construction of stages 08 and 09 additions to Watertown substation.	Lindstrom Construction Co., Grand Forks, N. Dak.	103,225
DC-5480	Collbran, Colo.	Mar. 16	Completion of Upper and Lower Molina powerplants and switchyards.	Martin K. Eby Construction Co., Inc., Englewood, Colo.	185,243
DC-5481	Hammond, N.M.	Mar. 8	Construction of Hammond diversion dam and Main canal, Sta. 38+96.35 to 44+50.	Skousen Construction Co. and Gaylord F. Chapel, Albuquerque, N.M.	403,980
DC-5482	Rogue River Basin, Oreg.	Mar. 15	Construction of earthwork and structures for West lateral rehabilitation and extension of West lateral.	Pacific Concrete Co., Portland, Oreg.	689,333
DC-5483	Klamath, Oreg.-Calif.	Mar. 7	Construction of earthwork and structures for laterals and drains, Sump 2, Contract Unit 3.	George W. Lewis, Kennewick, Wash.	187,389
DC-5486	Missouri River Basin, Mont.-Wyo.	Mar. 23	Construction of nineteen 3-bedroom residences for Yellowtail dam government community.	C & M Construction Co., Billings, Mont.	265,200
100C-424	Columbia Basin, Wash.	Jan. 12	Construction of Weber wasteway underdrain extension.	Cherf Brothers, Inc., and Sandkay Contractors, Inc., Ephrata, Wash.	115,727
400C-159	Provo River, Utah	Feb. 10	Construction of Stewart Ranch Park dikes, Smith Rest Haven bank protection, Mile 15.2 rock drop and turnout, and Provo River channel revision.	Ford Construction Co., Inc., Provo, Utah.	137,400
617C-64	Missouri River Basin, Wyo.	Mar. 8	Construction of open and closed drains near Worland, Wyo.	Lowe Construction Co., Billings, Mont.	133,825

Major Construction and Materials for Which Bids Will Be Requested Through May 1961*

Project	Description of Work or Material
Central Valley, Calif	Constructing Spring Creek Dam, a 1,800,000-cubic-yard earthfill structure, 190 feet high and 1,200 feet long, and appurtenant structures. On Spring Creek, about 4 miles northwest of Redding.
Do	Constructing about 14 miles of 8- to 21-inch-diameter El Dorado pipelines. Alternative bids will be requested for pretensioned concrete cylinder pipe, noncylinder prestressed concrete pipe, asbestos-cement pipe, and mortar-lined and coated-steel pipe. Work will also include constructing 2 earth-lined reservoirs and 1 concrete-lined reservoir. Near Placerville.
Do	Constructing a treatment plant (Reservoir No. 2) for the El Dorado Distribution System will consist of a 24- by 20-foot building of reinforced concrete masonry units and furnishing and installing chlorination equipment. Northwest of Sacramento.
Do	Constructing about 19 miles of 30- to 48-inch-diameter cast-in-place concrete pipelines and about 10 miles of open laterals. Madera Extensions, near Madera.
Do	Conductor, insulators, steel strand, and miscellaneous hardware for 14 miles of single-circuit and 12 miles of double-circuit 230-kv transmission lines. Trinity-Clear Creek, Clear Creek-Keswick, Spring Creek-Keswick Transmission Lines.
Do	Single-circuit, 230-kv, steel transmission towers for the Trinity River Division. Estimated weight: 820 tons.
Do	Double-circuit, 230-kv, steel transmission towers for the Trinity River Division. Estimated weight: 1,130 tons.
Do	Fabricated structural steel for 230-kv line take-off structures for Trinity, Clear Creek, and Spring Creek Powerplants. Estimated weight: 80 tons.
Chief Joseph Dam, Wash	Constructing about 34 miles of 4- to 27-inch-diameter pipelines for heads up to 450 feet. Work will also include constructing 2 small pumping plants and 2 concrete-lined reservoirs, one 40 by 100 feet and the other 47 by 47 feet, both 8 feet deep. East Unit, near Wenatchee.
Do	Constructing a block masonry office, a shop building, and equipment shed and two 2-bedroom, wood-frame residences for the Greater Wenatchee Division, near East Wenatchee.
Collbran, Colo	Constructing a 3-bedroom residence and double garage at Bonham Dam, about 10 miles south of Collbran.
CRSP, Ariz	Eight 13.96- by 22.45-foot fixed-wheel gates for the Glen Canyon Powerplant. Estimated weight: 1,852,000 pounds.
Do	Eight hydraulic hoists, including support beams, base plates, intermediate stems, gate stems, and storage equipment for the Glen Canyon Powerplant. Estimated weight: 825,000 pounds.
Columbia Basin, Wash	Converting a 2-unit outdoor pumping plant to an indoor pumping plant with an addition of 4 horizontal pumping units. White Bluffs No. 2, south of Othello.
Hammond, N. Mex	Constructing the indoor-type Hammond Pumping Plant, near Farmington.
Do	Constructing about 41 miles of Hammond Main Canal and Laterals part of which will be lined with compacted earth lining. Near Farmington.
Lower Rio Grande Rehabilitation, Texas.	Rehabilitating about 6.8 miles of laterals will consist of reshaping the prism and banks, constructing about 2.7 miles of unreinforced concrete lining in new section, and constructing 36-inch-diameter pipe lateral to replace about 4.1 miles of open lateral. 13.0 Lateral System, near Santa Rosa.
Lower Rio Grande Rehabilitation, Texas—Continued.	Rehabilitating about 5 miles of B&D Laterals, near Mercedes.
MRBP, Iowa	Constructing the Spencer Substation (Stage 01).
Do	Constructing the Dension Substation (Stage 01).
Do	Constructing the Creston Substation.
MRBP, Minn	Constructing the Morris Substation (Stage 01).
MRBP, Mont	Furnishing and erecting thirty-three 3-bedroom relocatable houses for the Yellowtail Government Camp, about 45 miles southwest of Hardin.
Do	Furnishing and erecting fourteen 5-stall garages and 3 washhouses for the Yellowtail Government Camp, about 45 miles southwest of Hardin.
MRBP, S. Dak.-Iowa	Radio equipment for Arlington (modification), Sioux Falls, LeMars, Charter Oaks and Exira Relay Stations; and Spencer, Denison, and Creston Terminal Stations.
MRBP, Wyo	Constructing the Raderville Substation.
San Angelo, Tex	Earthwork and structures for about 16 miles of the concrete-lined Main Canal, including a 5- by 6-foot reinforced concrete box headworks structure to be constructed through the Nasworthy dam. Near San Angelo.
Do	Three 12- by 15-foot fixed-wheel gates for Twin Buttes Dam. Estimated weight: 210,000 pounds.
Seedskadee, Wyo	Constructing Fontenelle Dam, a 5,200,000-cubic-yard earthfill structure, 127 feet high and 5,200 feet long, appurtenant structures, and constructing about 3.6 miles of access road. On Green River about 30 miles northeast of Kemmerer.
Do	Constructing a 36- by 102-foot administration building; a 40- by 60-foot warehouse; a 30- by 110-foot garage, fire station, and laboratory; a 10-stall garage; four 4-stall garages; seven 2-stall garages; a washhouse; and a laundry building. Construction is to be of concrete block, woodframe, and prefabricated metal. Fontenelle Community, about 28 miles northeast of Kemmerer.
Do	Constructing eight 3-bedroom and two 2-bedroom residences. Fontenelle Community, about 28 miles northeast of Kemmerer.
Smith Fork, Colo	Constructing the Smith Fork Feeder Canal Diversion Dam consisting of a concrete ogee overflow weir and canal headworks, and earthfill dikes extending to higher ground on both sides of the concrete structure, constructing about 2.7 miles of the Smith Fork Feeder Canal, 1.5 miles of which will be earth-lined, and constructing about 3.5 miles of the Aspen Canal, 1.75 miles of which will be earth-lined. Near Crawford.
South Platte River Projects, Colo.	Radio equipment for 7 fixed stations, 35 mobiles, and 3 portables. Bald Mountain, Blue Ridge, Limon, and Otis relay stations.
Uncompahgre, Colo	Removing about 1,000 feet of metal flume and supporting timber trestle in two locations about 0.5 miles apart and constructing a 78-inch diameter culvert and a 54-inch-diameter steel pipe crossing at the two relocated structure sites. East Canal, near Delta.
Weber Basin, Utah	Constructing 4 earth-lined reservoirs, including reinforced concrete inlet and outlet structures in each reservoir. Near Ogden.
Do	Constructing the indoor-type Willard No. 1 Pumping Plant and the outdoor-type Willard No. 2 Pumping Plant. Near Ogden.

*Subject to change.

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What's Coming:

Small Project Loans

Phantom on the 'Fry-Ark'

Reclamation

ERA

modern yuma pioneers

phantom on the fry-ark

$mall project loan$

KANSAS TURNS TO SECOND CENTURY

NEW RESEARCH IN EVAPORATION

AUGUST 1961

The Reclamation Era

AUGUST 1961 **VOLUME 47, NO. 3**

In this issue . . .

VIOLET PALMER, Editor
THEODORE R. McCANN, Art Editor

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small project loan$

A Federal program which is, in itself, a tribute to the initiative and self-reliance of people at the grassroots level was established when the Congress passed the Small Reclamation Projects Act of 1956 and it was signed into law by the President. Since that time, 19 water-user organizations in 5 Western States have had loan proposals approved and cleared with the Congress for the construction or rehabilitation of their own irrigation and water development projects.

The Small Reclamation Projects Act authorizes the Bureau of Reclamation to lend and grant up to nearly $5 million to a local organization for the construction or rehabilitation and betterment of a project primarily for irrigation with a combined Federal-local cost of not more than $10 million. The participating local water-user groups or State agencies plan and build their own projects. Nonreimbursable funds may be granted for flood control and fish and wildlife features that are of a general public benefit.

The program is part of the teamwork approach to natural resource development in which the Federal Government helps local water-user organizations to use their own planning and construction resources to solve water supply and distribution problems which do not require large-scale or complex and expensive developments. The contracting water-user groups repay the loans and operate and maintain the facilities.

Cameron County Water Control and Improvement District No. 1 in Texas was the first to utilize the provisions of the Small Projects Act. A repayment contract with the water users of the district, covering a loan of $4,600,000 for rehabilitation and betterment of the district's irrigation system, was approved by the Secretary of the Interior in March 1958; funds were appropriated by the Congress that summer, and construction was initiated in September 1958.

Another water-user group, whose experience in obtaining a loan probably illustrates as well as any other the necessary steps, is the Georgetown Divide Public Utility District in El Dorado County, Calif.

Cameron County District

Cameron County Water Control and Improvement District No. 1, Harlingen, Tex., known locally as the Harlingen District, is one of the 33 districts serving the irrigated area of some 700,000 acres in the Lower Rio Grande Valley in south Texas.

The climate of the area is semitropical and semiarid. Average precipitation is approximately 26 inches annually, but unfortunately is not distributed to permit full beneficial use for crop production. The Harlingen District contains a gross area of 43,971 acres, of which about 39,000 acres are irrigated. Water supply comes from the Rio Grande.

Irrigation development started in the valley about 1876 when labor was cheap. The systems first laid out were designed for low initial cost, anticipating considerable maintenance. With increased cost of labor and increasing value of water, it became necessary to modernize and improve the efficiency of many of the irrigation systems.

At left, section on Cameron County, Tex., project is completed by ditcher. Template in foreground is for checking. Below is rear view of slip-form placing 2.5-foot base-width concrete lining.

The Harlingen District requested the Bureau of Reclamation to make an investigation and prepare a report presenting a plan and cost estimate for modernization and rehabilitation, and advanced the Bureau $12,000 to defray its share of the investigation expense. The report was completed in February 1956 and was being processed for submittal to the Congress, with recommendations for its authorization and construction by the Bureau of Reclamation, when the Small Reclamation Projects Act of 1956 was passed as Public Law 984 of the 84th Congress.

The district requested the Secretary of the Interior to then withhold submittal of the report, because it preferred to secure funds under the small loan program and do the proposed work with its own forces.

An application was submitted by the district in February 1957, requesting a loan of $4,600,000. The application was approved by the Secretary of the Interior on July 5, 1957, and the repayment contract with the district was signed on March 24, 1958. The first quarterly advance of loan funds, $440,000, was made to the district on July 25, 1958. Thus, it was not only the first such project to be approved but was the first to actually start work under the Small Projects Act.

The district has used loan funds to purchase construction equipment for use in the rehabilitation program. The major item purchased was a specially made Buckeye ditcher that cuts the canal prisms to a neat line and grade ready for immediate placement of concrete lining. Canal lining is placed by a subgrade guided slip-form machine that follows closely behind the ditcher. Concrete for the lining is supplied to the slip form by a local ready-mix plant under contract.

When necessary to avoid interrupting water deliveries during the work, temporary bypass channels have been excavated along the side of the canals and lined with sheets of polyethylene. The lining prevents saturation of material in the canal section during compaction of the earthfill, excavation, and lining operations. After a section of the canal is completed and put in service, the polyethylene lining is removed for later reuse. The temporary channel is filled and the land is leveled and put back into crop production.

The larger laterals are also being concrete lined. Roadways are constructed on both banks of the canals and laterals to permit use of modern mechanical equipment for weed control. The smaller laterals are being placed underground in precast concrete pipe which reduces water conveyance losses and eliminates nearly all the maintenance costs of weed control and cleaning operations. A

2-foot minimum cover permits the land formerly occupied by surface laterals to be put into crop production.

The river pumping plant has been completely rehabilitated. The pumps were rebuilt to improve their operating efficiency, and the old electric motors were replaced with new natural gas engines to reduce the cost of pumping energy. This was accomplished under contract at a cost of about $130,000.

The district has experienced several unusual and prolonged rainy periods since construction was initiated. This has slowed the work somewhat, but it is still anticipated that the job will be completed as scheduled, about June 30, 1963.

Georgetown Divide District

Nine years ago the Georgetown Divide Public Utility District in California purchased the inadequate, wornout, and failing water supply system serving its area. In addition to the antiquated system and a limited agricultural development based chiefly on irrigated pasture, the district's chief assets at that time were foresight, courage, and initiative. Today, with the aid of a Small Reclamation Projects loan, the district is constructing a new project that will double its water supply and greatly improve its financial situation.

The setting for this accomplishment really began to take shape as early as 1849—long before the advent of Federal reclamation—when miners found gold-bearing gravels in the Sierra Nevada foothills between the Middle and South Forks of the American River, just a few miles from Coloma,

Polyethylene-lined bypass channel along side Cameron County canal permits continuation of water deliveries during rehab work.

where John Marshall picked up the few small pieces of yellow metal that started the California Gold Rush. One of the settlements which soon grew up around the "diggins" was Georgetown, which gives the district and area its name.

Unlike Coloma on the South Fork American River, the Georgetown gravels were located in the rolling "Divide" country, high above the waters of the main streams, and the miners soon found the small local streams inadequate for washing their gravels except during intermittent winter and spring rains.

To remedy this, they went into the high, glaciated granite country near the Sierra's crest, and closed the outlet of little Loon Lake with a dam of hand-shaped blocks of stone to store enough water to last through the dry summer and fall months. Since it was located 2 days' pack trip through rugged mountains from Georgetown, the point of need, the miners led the water along cliffs through wooden box flumes dropped precariously against the rock walls, down natural creek channels where they could find them, and through earth and rock ditches dug with pick and shovel. Altogether, the water had to travel over 70 miles from Loon Lake to supply the mines, homes, and business establishments of Georgetown.

As long as the mines were operating, there was plenty of gold to pay for expensive maintenance, but as they were worked out, use of the water was increasingly diverted to irrigation of widely scattered lands on the Divide until most of the water sales were for this purpose.

With such a limited source of revenue, the ditch company's income and profits were small, so that only the most necessary maintenance was carried on. Over the years, this resulted in deterioration of the system until it was a continuous struggle to keep it in operation and deliver a fraction of the water available at the source.

This was the situation in 1952 when a series of severe winter storms wrought a hundred thousand dollars' worth of damage to the system, which the water company had neither the desire nor resources to repair. Faced with total loss of their water supply, people of the area formed the Georgetown Divide Public Utility District, contracted to buy the water system with 10 annual payments, and put it back into operation with the aid of State funds.

Over the next few years, the district made pay-

Contrast: Left, wooden flume, its days numbered, conveys Loon Lake water along Rubicon River (Calif.) canyon wall. Below, Georgetown Divide's new El Dorado Canal, now in operation.

ments on its debt and, with a very limited budget, embarked on a particularly well-conceived and well-executed rehabilitation of its distribution system. While this cut maintenance costs and improved water deliveries, it did little to lessen the near certainty of sooner or later having a winter heavy enough to wreck the high country flumes beyond the district's financial ability to repair.

About this time, another district—the Sacramento Municipal Utility District—proposed construction of a hydroelectric project on the adjacent Silver Creek watershed, and Georgetown's Loon Lake is so located that its waters can readily be diverted to the Silver Creek system for generation of power.

The resultant power value was enough so that Georgetown was able to sell its Loon Lake water rights for enough to build a new water supply reservoir on Pilot Creek comparatively close to the district, and a 10-mile canal to connect with the existing system.

However, the Loon Lake payment was to be by annual installments over 40 years, which was enough only to support a bond issue just sufficient to construct works to replace the old water supply, which was already inadequate to serve district lands. This meant continued high unit costs for water delivery and no opportunity to increase irrigated acreages to support profitably sized farm operations.

While the Georgetown District was pondering this problem, the Small Reclamation Projects Act (Public Law 984, 84th Cong.) was passed and signed into law.

Inquiry by the district's representatives at the Bureau of Reclamation's regional office at Sacramento confirmed applicability of the act to a proposed expansion project, and the district, with the aid of private consultants and State agencies, set about shaping a project and preparing a loan application that would meet its needs.

Because of the interest-free aspect of Small Project loan funds used for most irrigation purposes, the district will be able to use all of its Loon Lake payments to retire the project's capital cost, instead of using roughly half of them to pay interest on bonds. As a result, the district was able to propose a project doubling its old water supply, and this proposal contemplated a slight decrease in unit water costs even through the repayment period, with much lower costs eventually.

In 1958 Georgetown filed its application for a loan to construct this enlarged project, and after review by the State and appropriate Federal agencies, appropriation of funds by Congress, and negotiation, execution, and validation of a repayment contract, final design of the project works was completed and construction started in 1960.

(Continued on page 83)

PHANTOM ON THE *Fry Ark*

by R. J. STEINBRUNER [1]

The possibility of construction of the Fryingpan-Arkansas project is enough to brighten the eyes of the 350,000 residents of the Arkansas Valley today, townsmen and farmers alike, with the hope of saving their lands from water shortages.

And if the "Fry-Ark" had been developed 50 years ago, it might have saved, too, the Colorado Midland Railway—a valiant, colorful, indomitable bit of railroad that crammed more eventful history into its short 30-year lifetime than its less glamorous sister roads would know in a century.

The Colorado Midland's struggle to survive ended in 1918 under wartime pressures. Its motive power and rolling stock were scattered to the winds—including to Mexico and Cuba—all its tracks uprooted by 1922, its tunnels and wooden trestles allowed to collapse.

The Colorado Midland is dead, but its ghost will be looking on some day when the Fry-Ark is built. And the ghost will be laughing as it remembers how it overcame immense obstacles in the course of its own construction. It will have a right to be proud of its performance as it watches the relative ease of modern engineering.

Fry-Ark crews will drive to work on Colorado Midland roadbed. The prime contractor probably will move equipment, supplies, and men through a former railroad tunnel to get access to the project's own 5.3-mile tunnel through the ridgepole of the continent. Water in the enlarged Turquoise Lake will lap at the edge of the old roadbed, and the project's power and diversion canals will parallel the abandoned trackage in the upper reaches of the Arkansas Valley as far as Buena Vista.

Spread over about as much area as the railroad occupied, the plan of the proposed Bureau of Reclamation project requires an elaborate system of canals, tunnels, and closed conduits on the western side of the Continental Divide in central Colorado.

So laboriously gathered from the headwater tributaries of the Fryingpan River, an annual average of 69,100 acre-feet will be diverted through the new tunnel. Seven powerplants will generate 123,900 kilowatts as the water descends to the fertile farmlands and thirsty towns on the plains below.

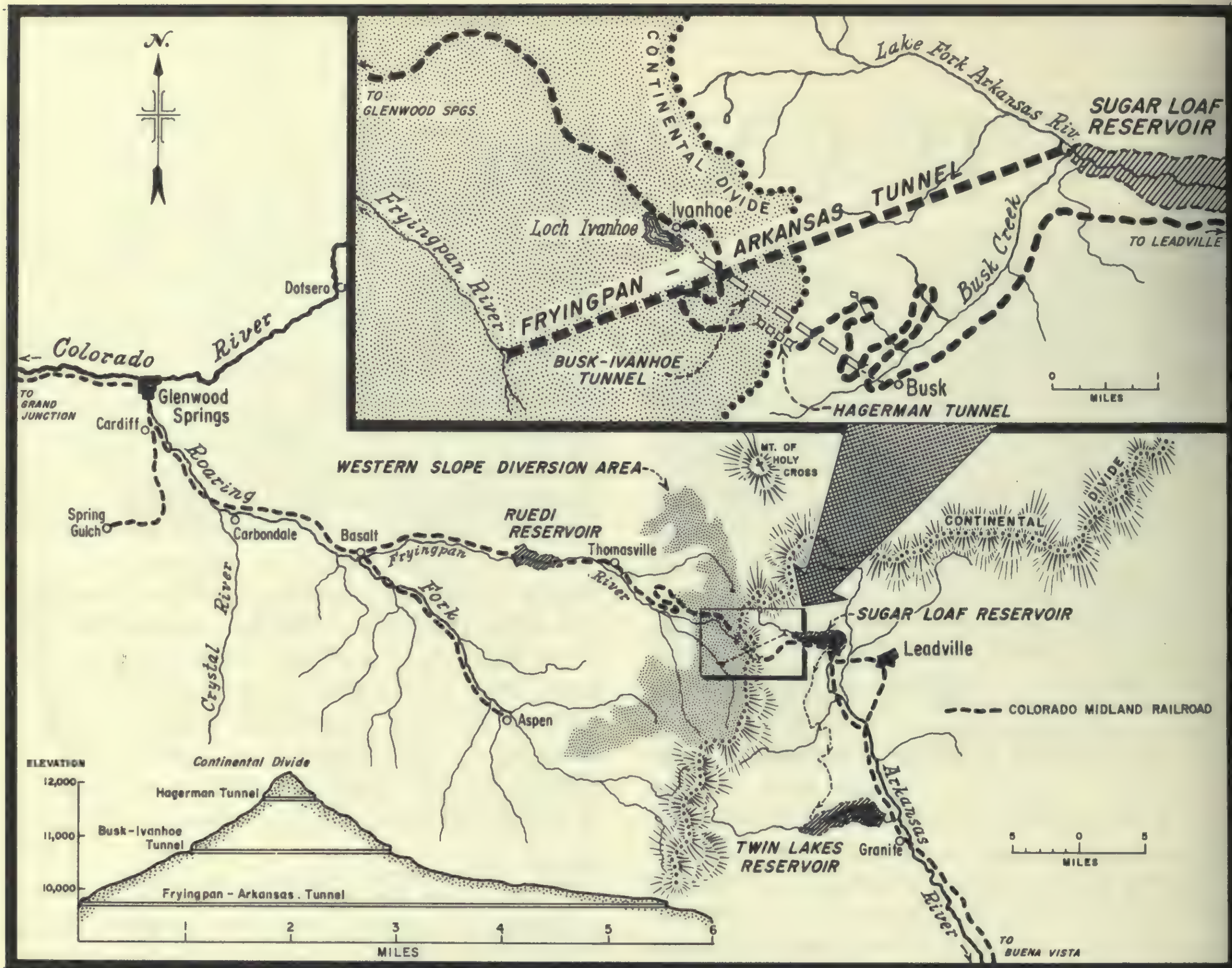
Construction men are practical, and they're not likely to be looking over their shoulders at the history behind them. Only the imaginative and historical minded among them will harken to the voices of the past.

The Colorado Midland's is the story of venturesome men. In the early 1880's Colorado was bursting with vitality and the creation of new wealth. Veins of silver, gold, lead, and zinc were being uncovered almost daily, and shacktowns sprang up in rocky valleys overnight.

Standard gage (4 feet 8½ inches) rail lines stopped at the eastern mountain front. The Denver & Rio Grande, Rio Grande Western, and Denver, South Park & Pacific sent their threads of steel into the mountains only 3 feet apart.

Men to whom a tough challenge was a joy imagined pushing broad-gage rails westward out of Colorado Springs to Leadville, biggest and boomingest mining camp in U.S. history; to Aspen on the western side, just entering its day of glory,

[1] Mr. Steinbruner was formerly field liaison officer, regional office, Denver, Colorado.



and on to Salt Lake City—a new transcontinental route.

Their inspired vision unlocked the purses of businessmen in Colorado Springs, Denver, New York, London, and elsewhere. Capital was raised that ultimately became $20 million, and construction of the Colorado Midland was underway with a whoop-and-a-holler that was typical of the daring and sureness of the America of that day.

Twenty-one months after the first shovel dug into earth on the right-of-way, traffic was moving over 238 miles of track. One historian aptly likened the profile of the railroad to a roller coaster.

Spectacular as were the reaches to east and west, most spectacular was the assault on the Continental Divide. Hagerman Tunnel, named for James John Hagerman, organizer and first president, was 2,164 feet long, piercing Sugar Loaf Mountain less than 500 feet beneath the summit at an elevation of 11,528 feet.

Sixteen miles west of Leadville, the "Midland Loup" afforded ascent to the tunnel. From Busk to portal less than an air-mile away, the railroad doubled back on itself twice, one of the times on a curving wooden trestle 1,084 feet long. Hagerman Tunnel was used only for brief intervals on two occasions. A substitute tunnel located 600 feet lower was 9,398 feet long, but eliminated 7 miles of road terrible to climb and terrible to maintain. The western portals of both tunnels were near Lake Ivanhoe.

Both tunnels were in a northwest-southeast direction; the Fry-Ark irrigation tunnel will be beneath them at right angles, southwest-northeast.

This was no shabby, second-rate road. From

This is a sample of the "cliff-hanger" roadbed of the Colorado Midland, a railroad as colorful as the mountain scenery.

the first big "Consolidations" bought in 1887 to the last in 1907, the Midland purchased the newest and best motive equipment. Its pullman cars were mahogany and oak, maroon and gold plush, silver trimmings, carpeting by Wilton.

The Colorado Midland's operating experience had as many peaks and valleys as its profile. The first years were prosperous. Metallic ores cascading out of the hills surrounding Aspen had to be transported to the reduction mills and smelters at Leadville. The smelters needed coking coal from Carbondale and Cardiff, and the eastern mines needed western timbers. The expanding mountain ranches had stock to ship. Westbound traffic carried equipment for the mines and supplies for the growing population.

Other prosperous times came and went through various ownerships. The last owners, a group led by A. E. Carlton, mining tycoon, rebuilt the traffic volume, capitalized on the road's slogan "The Pike's Peak Route" to draw more travelers over the highly scenic lines, modernized much of the mileage, and purchased rolling stock.

But then during World War I, adversity overtook the Midland and funded debt crushed it. Costly to build and operate, it could never get out from under the load of interest payments. Short-term notes were needed to pay interest on long-term bonds.

The panic of 1893 and demonetization of silver were disasters. Strikes in mines and smelters and a shop fire fell only a little short of "disaster." Competition by other lines was savage.

Maintenance was expensive and wrecks on the mountain slopes were frequent. Winter snows were always a problem, most dramatically demonstrated in the winter of 1899 when the road was closed for 78 days by drifts as high as 45 feet.

So the Colorado Midland finally gave up. Rotting ties show where it went in some areas, and in others the roadbed has become a road for vehicles. The lower tunnel, first known as the Busk-Ivanhoe and then as the Carlton, was used for vehicles until cave-ins made maintenance too expensive.

The Rocky Ford Highline Canal Co., which diverts western slope water, recently completed a million-dollar rehabilitation of the 15- by 21-foot tunnel and its concrete conduit.

Some day soon, Congress willing, men and machines again might be passing through the tunnel and traveling the awe-inspiring stretch on the western side, which includes the well-named Hell Gate section and where the convolutions are 11 miles by road to descend what is three-quarters of a mile by trail.

Did we say the Colorado Midland died? That isn't completely true—in one sense, the Midland will never die. # # #

McLaren ranch in Fryingpan Valley and Colorado Midland roadbed. Ruedi Reservoir, 7 miles west, would back water close to ranchstead. *(Colorado Midland photos courtesy George McLaren.)*

YOUR MAGAZINE

Are there particular types of articles which you would like to see in the Era that we have not printed to date? If so, please let us know, and we shall do our best to comply with your wishes.

Crop Report

The Bureau of Reclamation's "Crop Report" for 1960 has been completed and copies are available from the Washington office. Some of the highlights from this new edition include:

Federal reclamation projects during 1960 were capable of providing irrigation water service to 8,171,157 acres, an area 76,774 acres greater than that of the previous year.

The area actually irrigated in these projects amounted to 6,899,711 acres, an increase of 100,960 acres over that irrigated in the previous year. Approximately half of the area consists of privately built projects which were rehabilitated or provided supplemental irrigation water from Federal projects.

The irrigated lands produced $1.2 billion worth of crops. The average gross value of crop production per acre was $167.76. Crops grown include a wide variety of food and specialty items particularly adapted to western growing conditions.

Crops commonly produced under irrigation in the West are, for the most part, those in limited supply, or those which find a ready local market because of the isolated locations of the projects in the West's vast rangeland areas. Therefore, reclamation project farms contribute little to the current buildup of surplus farm commodities. Unlike many one-crop dry-farm areas, the factors of production on irrigated farms are controlled, permitting flexibility and change in response to market needs.

The farms served by the water storage and supply systems on Federal reclamation projects number more than 128,000 and have a population of over a half million persons. Project lands once farmed, but now taken up in surburban developments due to growth of the irrigation communities, provide homes for about another million persons.

The domestic and industrial water supplies of numerous cities and towns were augmented in 1960 to the extent of some 395 billion gallons of water from reclamation sources. More than a million persons live in these communities.

The reclamation program serves to stabilize farming in many areas of the Western States, as well as to provide a wide array of important specialty crops. Since the first harvest of reclamation crops in 1906, the cumulative value of crops produced has exceeded $16.5 billion. # # #

RECREATION at man-made lakes

PART II

In the late summer, most people have returned to work "to rest up" from their vacations. Others, however, escape the letdown of August and early September by saving their vacations until then.

Three rather widely separated areas, each blessed with Bureau of Reclamation multiple-purpose water development projects, are among those offering a choice of water-related recreation and sightseeing to the Johnny-go-lately.

The three areas to be considered in this article are Quartz Mountain State Park in Oklahoma, just a stone's throw—as distances are measured there—from the Texas Panhandle; the man-made lakes in the southwestern quarter of Colorado; and the area fanning out through Utah from Salt Lake City.

Quartz Mountain

Indians were the first men to utilize the land of Quartz Mountain State Park in historic times, camping there and building a village.

Spaniards discovered the Quartz Mountains which surround the North Fork of the Red River sometime around 1611.

Earliest American exploration of the area was recorded in 1834 when Colonels Henry Leavenworth and Henry Dodge, stationed at old Fort Gibson in eastern Oklahoma, met a group of Comanches who guided them to the large Wichita village where they met with Comanche, Wichita, and Kiowa Tribes.

The park area, in Oklahoma's southwestern sector near Hobart, Mangum, and Altus, was claimed at various times by France, Spain, and the Republic of Texas.

Things have changed quite a lot in the old stomping grounds. The mountains are the same—rocky and intriguing. But today man's hand has created a lake from the river, and among the hills built a modern vacationer's dream. The lake was created by the Bureau of Reclamation.

Altus Reservoir is a multipurpose reservoir providing water for municipal, irrigation, and flood control purposes. In addition, the water and surrounding area have become particularly attractive for recreational use. A contract between the United States and the Oklahoma State Planning and Resources Board provides for the State to administer lands marginal to the Altus Reservoir

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for park and recreational purposes. Full development of the recreational facilities which are available has been provided through the overall planning and at the expense of the State.

On the shore of 6,810-acre Lake Altus, Quartz Mountain lodge is a 46-room resort offering a myriad of year-round facilities. A nine-hole golf course, opened in 1960, is an attraction in the 7,560-acre park. Overnight accommodations other than the lodge are 10 housekeeping cottages and 3 new duplex cottages which were scheduled for opening this summer. The lodge and cottages are air conditioned.

Quartz is popular with fishermen, boaters, skiers, and swimmers. A large concrete and tile swimming pool with bathhouse is near the lodge and the lake.

Picnickers and campers find plenty of room in the scenic park. Picnic shelters, grills, and tables are numerous, and restroom and shower buildings are convenient for park visitors.

Boats, motors, and ski equipment are for rent, and ski tow service is available in the park. Bait may be purchased and a dock is near the lodge for fishermen who want to drop by for a quick snack, or for guests who wish to tie up near the lodge.

A terrace near the coffee shop is the scene of dances under the stars on spring, summer, and fall evenings.

Fishing in comfort is an attraction of the enclosed Fisherama which is air conditioned in summer, heated in winter.

Southwestern Colorado

Deep, azure-blue jewels—set in the scenic wonderland stretching from the Continental Divide of the southern Rocky Mountains to the Four-Corners area where Colorado meets New Mexico, Arizona, and Utah—these are lakes *made* for you. They are reclamation reservoirs formed behind dams built to store water for farms, towns, and industries. And, as a bonus, these reclamation lakes offer recreational opportunities to thousands who wish to bask on the sunlit shores, to boat and water-ski on the clear blue water, and to outwit the wily trout.

Highways lead from Pueblo, Colorado Springs, and Denver to this quarter of Colorado by way of U.S. Highway 50, with the gateway at Monarch Pass, elevation 11,312 feet.

Nestled close to the Continental Divide and about 35 miles northeast of the town of Gunnison, which is on U.S. 50, is Taylor Park Reservoir. Here are stocked German Brown and Rainbow trout and the Kokanee salmon, where nearly 70,000 fish were caught in 1960.

Public campgrounds, picnic facilities, and cabins are available at Taylor Park Reservoir, which is administered for recreation purposes by the U.S. Forest Service. Also, with regulated releases of water from the reservoir, the Taylor River provides a fine trout stream for 25 miles below the dam with many camping spots along the river.

As a traveler heads west and nears Montrose, Colo., he can make a side trip a few miles north to visit the Black Canyon of the Gunnison National Monument. This world-renowned masterpiece of Nature is located on the deepest gorge of the Black Canyon of the Gunnison. Here, the rims of the gorge are only 1,300 feet apart at the crest, yet the gorge is 2,425 feet deep and only 40 feet wide at the bottom. Visitors can drive their cars to the very rim of the gorge for the breathtaking view.

Montrose is situated in the heart of the Uncompahgre project, a Federal reclamation project completed prior to World War I. The prosperous farmlands on this project are made possible by the water stored in Taylor Park Reservoir, nearly 70 airline-miles to the northeast.

South of Montrose, on U.S. Highway 550, is the Ute Indian Museum.

Continuing south on U.S. Highway 550, the traveler soon reaches Ouray, Colo., a friendly town set deep in a box canyon. Here, visitors can arrange for jeep trips over traillike roads leading into the high reaches of the San Juan Mountains, which are speckled with old mining towns and mountain scenery beyond parallel.

The "Million Dollar Highway" takes the traveler over Red Mountain Pass (elevation 11,018) from Ouray to Silverton, Colo. Silverton is a famous old mining community, now dedicated to presenting to the tourist an authentic sampling of the old mining West.

About 60 miles southward is the bustling city of Durango, Colo., where the tourist has many good reasons to pause in his travel. The last narrow-gage passenger train makes a round trip from Durango to Silverton each day during the summer. Hundreds of tourists jam onto this train which follows the Animas River Cañyon,

Nestled near Continental Divide, Taylor Park Reservoir in Colorado serves Uncompahgre project and doubles as recreation area.

where no auto road penetrates.

Northwest of Durango on the Los Pinos River is another reclamation lake—the Vallecito Reservoir—set in lush pine forests at an elevation of 7,600 feet. In 1960 more than one-quarter of a million fish were taken from the clear, cool water of the lake. Excellent facilities of all kinds are available for the comfort of visitors.

The traveler who heads west from Durango on U.S. Highway 160 finds another reclamation lake on his path. It is the Jackson Gulch Reservoir just 5 miles northwest of Mancos, Colo. Although it is a small lake, fishing is good. More than 18,000 fish were taken in 1960.

Salt Lake Area

Salt Lake City, Utah, at the crossroads of the West, is situated at the foot of the towering, snow-

clad Wasatch Mountains. It is the center for a growing agricultural and industrial empire which has been made possible by the continuing development and use of the limited water supplies from mountain streams.

Through the years, many reclamation lakes have been built in the mountain areas north, east, and south of Salt Lake City. As in other areas, these lakes not only play an important part in transformation of desertland into farms, industries, and cities, but they also provide attractive recreational opportunities.

The highlight of any traveler's visit to Salt Lake City is Temple Square. Almost any day in the year finds Temple Square flanked by out-of-State cars. Visitors, as well as seeing Mormon Temple and Tabernacle and the beautiful temple grounds, can hear daily concerts on the great tabernacle organ and, on Sunday, attend the CBS radio broadcast by the Tabernacle Choir.

Just minutes away from downtown Salt Lake City, in the canyons of the Wasatch Mountains, are Alta and Brighton, world-famous ski areas, noted for their excellent, deep, powdery snow. In the summertime, visitors find the forested canyons of the Wasatch delightful places for an early morning breakfast, a lunch stop, or an evening picnic where an open fire is welcome against the chill of the mountain air.

The traveler who stops at Salt Lake City finds reclamation lakes beckoning from the north, east, and south. If he heads north, he will find the Pineview Reservoir on the Ogden River just a few miles east of Ogden, Utah's second city. At Pineview Reservoir the Bureau of Reclamation, in cooperation with the U.S. Forest Service, has provided picnicking, camping, and boating facilities. Water skiing and boat racing are particularly popular. Fishermen are finding the lake attractive, too, since it was treated in 1959 to eliminate trash fish and then restocked with game fish. Last year, more than 300,000 people enjoyed outings at Pineview Reservoir.

Northwest of Salt Lake City, near Corinne, Utah, is Promontory Point, where on May 10, 1869, the golden spike was driven to complete the first transcontinental railroad. A railroad museum has been recently established at this point and houses an interesting exhibit of mementoes of that historic day and displays which commemorate railroad's "Age of the Steam Locomotive."

If the visitor to Salt Lake City should choose to head east, he should be sure to take his fishing pole. About 40 miles to the east are Rockport Lake (formed by Wanship Dam) and Echo Reservoir on the Weber River; then Strawberry Reservoir, the favorite "fishing hole" for many Utah fishermen who know where the fishing is good; and even farther east to Duchesne, Utah, thence north to Moon Lake Reservoir, which is in the lovely pine forests on the lower flanks of the Uinta Mountains. At Moon Lake there are excellent camping facilities and cabins for those who desire a little more of the comforts.

Quartz Mountain State Park evolved at Altus Reservoir which provides irrigation and municipal water and flood control.

The venturesome traveler will proceed onward to Vernal, Utah, where the dinosaur is "king." Here he can visit the Dinosaur National Monument and the Utah Field House of Natural History, which presents the intriguing story of the gigantic dinosaurs who ranged the area millions of years ago.

The traveler who decides to head south from Salt Lake City will find first Timpanogos Cave National Monument located in American Fork Canyon and also Deer Creek Reservoir and Scofield Reservoir.

Many visitors to Salt Lake City arrive or leave by U.S. Highway 40 which extends west across Nevada to San Francisco. On this route are the swimming beaches of the Great Salt Lake. There is nothing quite comparable to swimming in the heavy water of the lake in which the swimmer will experience the eerie feeling of bobbing like a cork . . . which might, after all, be the best of all ways to feel on a vacation during the lazy last days of summer. # # #

NEW research in evaporation

Bureau of Reclamation researchers have launched an intensive 5-year research program to develop practical methods of reducing the evaporation loss of valuable water from large reservoirs. This program is designed to solve problems uncovered during the Bureau's previous laboratory and field research.

The Bureau's evaporation reduction work began in 1952 when the study was first considered. Later, laboratory and preliminary field tests proved promising; and in 1958, a large-scale evaporation reduction investigation was successfully performed at Lake Hefner, Oklahoma City. Another large-scale evaporation reduction investigation was carried out at Sahuaro Lake on the Salt River project, Arizona, in 1960.

The current 5-year program, begun in 1960, covers three broad areas of research—field investigations, Reclamation laboratory research, and Bureau-sponsored research at selected universities and other institutions. The Bureau's research scientists are vigorously pushing the three-pronged attack on evaporation reduction investigations. They know the urgent need for solution to the problem stemming from the fact that each year evaporation from fresh-water sources in the 17 Western States steals about 24 million acre-feet of precious water. This huge quantity of water is nearly equivalent to the capacity of Lake Mead behind Hoover Dam on the Colorado River.

The common denominator of the research effort is the established principle that evaporation from water surfaces can be reduced by the use of a chemical film known as a monomolecular layer or monolayer—a covering one molecule thick.

Of the more than 200 monolayer forming compounds, or combinations of such compounds, studied by the Bureau's researchers, the substances which offer the most promise of application to water surfaces are combinations of two alcohols, hexadecanol and octadecanol. A layer or film of hexadecanol is only about six ten-millionths of an inch thick. The film is invisible, although its presence on a lake can frequently be seen by the film smoothing out ripples on the surface.

There are many engineering difficulties encountered when an evaporation-reducing film is applied to lakes and reservoirs. These engineering problems vary with the size and shape of the body of water and climatic conditions which are prevalent when the applications are made. Scientists have also discovered that there are many other puzzling fundamental questions yet to be answered before the most efficient material can be specified as an evaporation retarder.

by L. O. TIMBLIN, JR. Head, Physical Investigations Laboratory Section, Denver, Colo.

Field investigations—the first of the Bureau's three approaches to solution of these problems—are being carried out by Reclamation scientists and engineers working in collaboration with other agencies and organizations, and with the cooperation of local and State authorities. For each field test, careful studies are made of winds and other climatic conditions at reservoirs. These studies are helpful in developing proper equipment and ways of using the equipment to apply and maintain monomolecular layers at the lowest cost and the highest efficiency.

The behavior of monolayers under field conditions was studied at Lake Mead and Sahuaro Lake in the fall of 1959. These investigations yielded valuable additional information about the movement and persistence of the monolayer on large reservoirs and were preparatory to the first major field test under the 5-year program.

The first major field test was performed during the summer of 1960 at Sahuaro Lake by Bureau scientists in collaboration with the Geological Survey, the Salt River Valley Water Users' Association, U.S. Public Health Service, and the Arizona State Fish and Game Department. Sahuaro Lake is a 69,800-acre-foot reservoir formed by Stewart Mountain Dam on the Salt River project about 40 miles east of Phoenix.

During this study, several different techniques of applying the monolayer were investigated. One method was to melt the hexadecanol-octadecanol mixture, which at room temperature is a waxlike substance, and spray it through dispensers into the air over the lake. The dispensers were located at strategic points over the lake to take advantage of the wind blowing over the water surface. When the hot material was sprayed into the air, it cooled and formed small particles which gradually settled onto the water surface where they spontaneously formed a film. The spraying of melted materials was also tried from a boat traveling across the water surface and moving in an upwind direction.

Another technique tested at Sahuaro Lake was the dusting of the water surface with hexadecanol or octadecanol as a dry powder. Dusting machines mounted on boats sucked the dry powder from a barrel and blew it into the air over the lake surface where it was carried by the wind across the lake. The powder gradually settled to the water surface and formed the evaporation-reducing monolayer.

During the later stages of the Sahuaro Lake test, after improvements were made in the technique and equipment, extremely good and sustained coverages of the lake were obtained by the chemical film. Various commercial materials using different combinations of hexadecanol and octadecanol and similar compounds were tried.

The Geological Survey determined the evaporation reduction, using a process of measuring the heat energy coming into and leaving the reservoir. For the period October 1–November 17, 1960, the reduction was computed to be about 14 percent, resulting in a savings of about 62 acre-feet of water for the period. For the shorter period of October 19–November 17, the reduction was found to be about 22 percent, resulting in a savings of about 53 acre-feet of water for the period.

Another full-scale evaporation reduction test is being performed at Cachuma Reservoir this summer in cooperation with Federal, State, and municipal organizations. Cachuma Reservoir, near Santa Barbara, Calif., is about three times the size of Sahuaro Lake. Another large reservoir will be tested during the summers of 1963 and 1964.

The second aspect of the 5-year program is research by scientists in the Bureau's Engineering Laboratories in Denver. The researchers are screening various chemical film-forming materials.

The evaporation-reducing properties of various fatty alcohols and other materials which form monomolecular layers have been studied, and new materials will continue to be explored. To accelerate the screening program, the laboratories are developing a technique for a rapid, accurate measurement of the films' resistance to evapora-

(Continued on page 82)

Flow characteristics of spray nozzles are studied in lab in development of equipment for applying melted alcohols in field tests.

modern yuma pioneers

The fertile valleys and mesas on Bureau of Reclamation projects in the Yuma, Ariz., area on the Lower Colorado River again felt the homesteaders' plows following the end of World War II.

In the spring of 1948, the war's veterans began settling on their new land and started farming alongside oldtimers who homesteaded in the Yuma, Gila, and other valleys in the early days.

There were 26 farms in the Yuma Valley awarded at a public drawing in Yuma on March 10, 1948, and since then there have been 182 full-time farm units comprising 22,400 irrigable acres opened to entry or sold at a very nominal cost to qualified applicants under terms of public notices and announcements.

At left, Randy Fram, son of Mr. and Mrs. Bob Fram,
He began helping his father when he was 9 years ol
school hours. Family has about 40 head of dairy cow

Above, Patricia Rose Waldrip, one of three daughters o
ning trophy for her Grand Champion swine. Family
At right, children of Mr. and Mrs. Elliott Waits—Janet,
ing hungry babies for the 1962 Yuma County Fair co
the three are 4–H Club members. (*Waldrip photo cou*

Except for the farm units on the Yuma Mesa Division of the Gila project, the farms were undeveloped although irrigation water was available through constructed project works. Hard work, long hours, and considerable problems faced the new entrymen in establishing residence and in bringing the farms into the high state of development that exists today.

The cropping pattern in the Yuma area, and on the awarded reclamation farm units, is suited to intense agriculture with favorable climatic conditions permitting year-round planting. On the Yuma Mesa a large acreage previously in alfalfa is now planted to citrus, and on the Wellton-Mohawk Division of the Gila project the farming pattern tends toward field crops of alfalfa, Bermuda seed, melons, lettuce, cotton, small grains, and specialty seed crops. The Yuma project enjoys the same general farming pattern with a long, successful and profitable history of agriculture.

mily's dairy herd at milking time.
sidered full working hand outside
modern and herd is "Grade A."

Larry Lemke, son of Mr. and Mrs. Lawrence A. Lemke, shown on the front lawn of the family home, is raising and training this registered steer calf for 4–H Club competition. He and sister Janice have won many ribbons in such competition.

. William Waldrip, receives win-
orange groves on irrigated farm.
—handle morning chores, ready-
ike many other area youngsters,
unty Farmer.)

The young sons of Mr. and Mrs. Asil Dobson show their dad a thing or two. Mr. Dobson, alfalfa hay producer who is shown bailing hay in photo on page 71, also does his own mechanical work.

Here a Reclamation photographer has captured scenes of the typical development of farm units and family life of several original settlers. The entrymen have played an important role in the community life, with a number holding office in major water-user organizations and on agricultural committees dealing with the local farm problems.

While space permits the picturing of only a few entrymen and family members, those who are not shown have also exhibited the same industrious qualities to make the land settlement program successful and have contributed to the growth of the Yuma area. # # #

The Ernest Karkulas also produce alfalfa hay. Mrs. Karkula, mother of four, wins praise from husband as his "right hand" in the field.

Donalyn Fram, daughter of the Bob Frams, sews under the eye of her mother. Donalyn made the dress she is wearing.

KANSAS TURNS TO SECOND CENTURY

While Kansans in this their centennial year are reviewing accomplishments of the past, they also are eagerly anticipating the future.

There are numerous encouraging factors which already are speeding up the economic growth of the State. Not the least of these is the availability of irrigation water made possible by authorization of the Pick-Sloan plan in the Flood Control Act of 1944.

One hundred thousand acres of fertile cropland in north-central Kansas is or soon will be irrigated by water from five reservoirs. A million acres, largely in southwestern Kansas, is under irrigation from wells.

The most recent development is the reservoir system shown on the accompanying map of counties in north-central Kansas. If there is the expected expansion in irrigation and the resulting stimulus to economic growth that some predict, irrigation may be the major factor in the State's second 100 years.

The Bureau of Reclamation's water storage and irrigation distribution project in north-central Kansas, started in 1950, is virtually complete. This is an area where underground water is not available for irrigation purposes. Crop yields there under dryland conditions averaged from as low as 6 bushels an acre in 1956 to 29 bushels (grain sorghum, Republic County) in 1959.

Livestock numbers have fluctuated with the local feed grain and forage supply. Crop programs have been based upon wheat and grain sorghum because, under dryland conditions, they were less "risky" than some other crops.

Almost simultaneous with the Bureau of Reclamation start on water storage construction, Kansas State University personnel saw a need for an educational program which would give leadership to and guide farmers in their irrigation farming. The university and other agency personnel instituted an irrigation development farm program which would serve as a demonstration of irrigation farming methods.

by HAROLD SHANKLAND and RUSSELL L. HERPICH [1]

[1] Mr. Shankland is associate extension editor and Mr. Herpich is extension engineer at Kansas State University, Manhattan, Kans.

Cooperating with Kansas State University in this project were the Bureau of Reclamation, Soil Conservation Service, Farmers Home Administration, Kansas State Board of Agriculture, and the Agricultural Stabilization and Conservation Service.

The tremendous swing to irrigated farming in southwestern Kansas from underground water sources is shown on the accompanying table. As will be noted, only 250,000 acres of the present 1 million acres were being irrigated prior to 1950.

What will these irrigation developments mean to communities and farmers during the next century? Some of the benefits already are apparent. Others will follow with the next few years, and still other benefits may not appear for generations.

A chronological listing of these benefits is as follows: Stability of crop production, increased livestock production, modernization of community institutions, development of agriculturally related industries, and a shift in cropping programs.

An educational program being conducted cooperatively by the various U.S. Department of Agriculture agencies is designed to assist new irrigators in making a rapid transition from non-irrigated to irrigated crop production and to demonstrate the most efficient production practices for attaining consistently high crop yields. Two of these practices are high plant population and fertilization.

Farms which in 1955 and 1956 were producing crops sufficient for the maintenance of 30–40 head of livestock are now feeding 150–250 head per year. The Kansas-Bostwick irrigation development farm which in 1955 was supporting a beef cow herd of 40 head is now marketing 250–300 head of fat cattle annually. Plans are to expand this to a 500–600-head program during the next few years.

Kansas State University scientists have developed crop and livestock programs which permit the production of 150,000 to 200,000 pounds of beef per year from crops produced on 160 acres of irrigated land. Similar acreage will support 100 dairy cows, or 70 sows farrowing twice a year.

Wayne Kaser, who has been an irrigation demonstration farm cooperator since 1954 in the Webster project, has only 38 acres of irrigated land. In 1954 his livestock program consisted of 35 high-grade Hereford cows from which he marketed creep-fed calves each fall. His 1960 livestock program involved 97 head of steer calves. By 1963 he plans to winter 300 calves and to produce 100,000 pounds of beef annually in a wintering program.

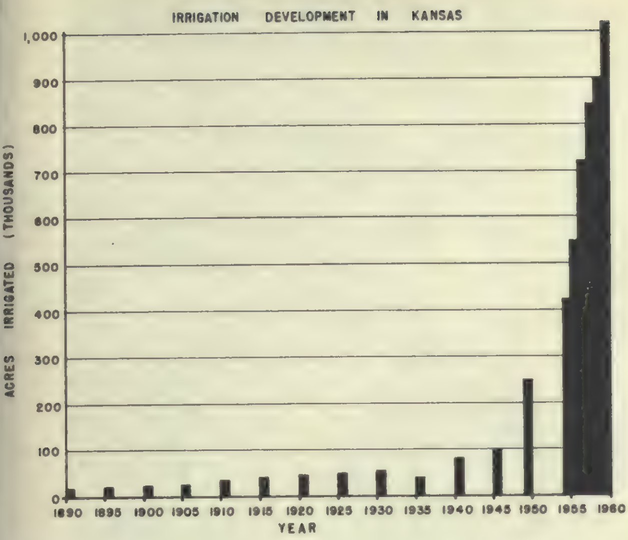
An extensive educational program is being conducted by Kansas State University to demonstrate the benefits from livestock programs which use large quantities of roughages. Assurance of abundant roughage feeds from irrigated farms in the Garden City, Kans., area prompted Earl Brookover to establish the first large-scale commercial feed yard in Kansas. There has been a marked increase in commercial as well as farm feed yards in all irrigated areas of the state.

During the past 5 years nearly all irrigated areas have seen a growing commercial feeding industry. These vary in size from individually owned 1,000-cattle-per-year units to those corporation owned which handle as many as 30,000 head annually.

Fertilizer distributors increased in communities in which there is irrigation development. Most irrigators spend from $10 to $12 per acre per year for fertilizer. For 50,000 acres of irrigated land, this would amount to an annual business of $500,000 to $600,000—a major industry for a community. Increased sales of equipment and employment also are tangible results of irrigation farming.

An example of an agriculturally related industry is a sorghum seed production plant which is

Most recent water resource development in Kansas is the reservoir system shown on this map of the State's north-central counties.



located in Grant County in the well-irrigated area of southwestern Kansas. The capital investment was more than $250,000 and the annual payroll is from $150,000 to $200,000 for full-time and seasonal employees. The seed producers' increased income is estimated at from $50,000 to $75,000.

As irrigation farming is a new type of farming to dryland operators, they first learn to produce crops with which they are familiar. In Kansas these are mainly corn and grain sorghum. However, there is a growing trend to move into the production of crops which offer the prospect of higher net returns.

Crops that are being considered are melons, peaches, apples, onions, head lettuce, oil seed crops such as soybeans and castorbeans, dry beans, blackeyed peas, silage and hay crops that are used in livestock feeding. Kansas State University has planted an apple orchard on its Belleville experiment field, and a rural economic development team has encouraged farmers in Rice County to develop their irrigation resources and to expand fruit production.

Irrigation's economic impact and stabilization of incomes will increase as the anticipated expansion of irrigated farming to 2 million acres in Kansas by 1980 is realized. Livestock men will be able to produce the feed crops needed to maintain their livestock numbers, feed crops will have a market, and agri-business concerns and communities will be able to continue on a sound basis.

# # #

THE ERA'S PURPOSE

The Reclamation Era is now well into its second half-century, having been published in its current and previous formats since 1905. It primary purpose is to help and to inform water users in general and Reclamation project water users in particular. Suggestions are always welcome for improving the content of the magazine so that it may better serve this purpose. We believe this magazine—which is somewhat unique as an official voice of the Bureau of Reclamation speaking directly to Reclamation water users—is the logical medium for keeping reclamationists informed on new ideas and progress in water resource development and use. An order form is printed below for the convenience of acquaintances of present subscribers who may be interested in receiving the *Era*. Orders should be sent directly to the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

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BUREAU'S LEADERSHIP FIRMED UP

W. DARLINGTON DENIT

W. Darlington Denit, 49, a career employee with 23 years' Federal service, has taken over as Assistant Commissioner for Administration in the Washington Office of the Bureau of Reclamation. He succeeds Alfred R. Golzé, who retired in mid-February to become chief engineer for the California State Department of Water Resources.

At the time Secretary of the Interior Stewart L. Udall announced Mr. Denit's appointment, he also announced that three other veteran career employees would continue to serve with Commissioner of Reclamation Floyd E. Dominy in top positions in the Bureau. They are Grant Bloodgood, Assistant Commissioner and Chief Engineer, Denver, Colo., and N. B. Bennett, Jr., Assistant Commissioner, Engineering and Power, and William I. Palmer, Assistant Commissioner, Planning and Irrigation, both in the Washington office.

Mr. Denit previously had been Director of the Inspection Division of the Department of the Interior in Washington. He was Comptroller of the Bureau of Reclamation from 1948 to 1953. He spent the early part of his Government career in the Department of Agriculture.

New Power Chief

Another recent Washington appointment is John W. Mueller as Chief of the Bureau's Power Division. Formerly with the Region 2 office in Sacramento, 1946–54, he was most recently with the Niagara Power project at Niagara Falls, N.Y. A native of Chinook, Mont., he received a degree in electrical engineering from the University of Nebraska. # # #

RECLAMATION MILESTONES

Fremont Canyon Powerplant. Fremont Canyon powerplant near Casper, Wyo., largest hydroelectric plant on the North Platte River, was dedicated in April. Water for the plant, which has a rating of 48,000 kilowatts, is provided by a pressure tunnel which extends to the toe of Pathfinder Dam, a 52-year-old Reclamation storage dam some 3 miles upstream.

Water Symposium. A Symposium on Basic Research in Civil Engineering Fields Related to Water Resources in Reclamation was held in June on the campus of Colorado State University at Fort Collins. It was sponsored by the Bureau of Reclamation, the American Society of Civil Engineers, and Colorado State University. It brought together leading engineers and scientist to stimulate interest in research in water conservation and utilization, soils, rock foundations, hydraulics, and other aspects of civil engineering essential to national water resources development. # # #

something new has been added!

Something new has been added to the Aqueduct Division of the Bureau of Reclamation's Provo River project in Utah.

It's the new Little Cottonwood water treatment plant of the Metropolitan Water District of Salt Lake City. This plant, officially opened December 17, 1960, and its supporting project have a unique history.

Shortly after its organization in 1935, the Metropolitan Water District elected to participate in the Bureau of Reclamation's Provo River project. The district became the largest stockholder in the Provo River Water Users Association, and thereby insured the feasibility of the Provo River project. Two project divisions were formed—the Deer Creek Division and the Aqueduct Division.

The Deer Creek Division is comprised of water collection features, a storage reservoir, and irrigation distribution features.

The Aqueduct Division, with which the water district is more directly concerned, is comprised of a 69-inch inside-diameter pipeline 41 miles long from the Deer Creek storage reservoir to the outskirts of Salt Lake City. At the terminus of the pipeline are the two Terminal Reservoirs with 20 million gallons' capacity in each.

Early in the design of the pipeline, a site for a future filtration plant was selected just upstream from the Terminal Reservoirs. Land was purchased and proper hydraulic conditions were built into the pipeline to make the construction of a plant at this site possible. However, the "population explosion" which has hit so much of the West also hit Salt Lake City, resulting in a homebuilding boom for several miles back along the aqueduct upstream from the proposed site for the filtration plant. It soon became evident that another site must be found which would better serve the expanding residential areas.

In 1955 a preliminary report was made by the consulting engineering firm of John A. Carollo, Phoenix, Ariz., in which it was recommended that

by VAUGHN B. WONNACOTT, Engineer-Superintendent
Little Cottonwood Water Treatment Plant

the treatment plant be located 8 miles upstream from the Terminal Reservoirs. Here the plant could be located adjacent to the pipeline, and the flow through the plant could be by gravity with only the lowering of a 660-foot section of pipeline further downstream.

This newly proposed treatment plant site would also make it possible to treat water from Little Cottonwood Creek, a nearby local stream—a conservation measure in itself—since the water from this stream, which was usually wasted because of high turbidities at spring runoff, could now be taken through the plant, cleaned up, and used in place of reserve storage water.

Construction of the treatment plant began in June 1958 and was completed approximately 2 years later at a cost of $7,500,000, including approximately $500,000 for property and engineering costs. The Metropolitan Water District has handled the construction financing independently of the Bureau of Reclamation under a bonding program approved 8 to 1 by the taxpayers of Salt Lake City. These bonds will be retired in 20 years with revenue from the sale of water.

Plant's Physical Features

The plant is classified as being of the conventional type, with screening, grit collection, aeration, coagulation, sedimentation, filtration, and chlorination. Automation is a keynote in all of the processes.

Two traveling screens which remove leaves and other debris from the local stream can be started and stopped as the operator sees the need, or can be put on an automatic, intermittent, timed program. A water spray which operates automatically whenever the screens are moving washes the leaves into a waste trough and out of the building for disposal.

The grit collectors, which are in the inlet end of the aeration basins, pick up the grit and gravel that comes from the local stream and remove it with a traveling chain and bucket arrangement.

Aeration basins have been provided to remove odors that are present in the Deer Creek Reservoir at various times of the year. The aeration process also oxidizes iron and manganese that may be in the water. The air that is bubbled up through the water is produced by three 200-horsepower blowers and introduced into the water through swing diffusers.

The next step in the treatment process is the addition of chemicals which combine with the water to form a floc that attracts impurities including turbidity, algae, bacteria, and iron and manganese oxides. The coagulation basins contain paddles which gently agitate the water to increase the contact between the floc and the impurities. This floc also has an electrical attraction for the impurities which enables it to sweep the water clean. This "sweeping" also continues in the sedimentation basins as the floc settles out. Then, at the downstream end of these basins, an improved water is drawn off the top and introduced to the filters.

Filtration is a "polishing up" process—the final step in purification. In the filters the water passes through 2 feet of sand and 1 foot of graded gravel to the finished water channel and thence to the consumer.

And, for the most part, the consumer is the same man that purchases the fruits, vegetables, and grains from the irrigated farms served by the Provo River project. Thus exists the happy marriage of the domestic and irrigation features of a Bureau of Reclamation project. # # #

Bureau-built Salt Lake Aqueduct takes water to new filtration plant.

TWO DIE IN OVERSEAS ACCIDENT

Two Bureau of Reclamation employees, Earl R. Fogarty, 60, and Howard J. Ferris, 47, were killed in April in a helicopter accident while they were making an aerial reconnaissance of the Blue Nile River Basin in Ethiopia.

Mr. Ferris, soil scientist, was a member of the staff of the Bureau's Blue Nile Reconnaissance Project. Mr. Fogarty, Chief, Economics Resources Branch, Denver, had been on a 3-week detail to the Ethiopian project to conduct a review of land classification and economic studies.

Commissioner of Reclamation Floyd E. Dominy said, "Mr. Fogarty and Mr. Ferris, like the other members of the project staff, were engaged in arduous work under difficult conditions that called not only for a high degree of technical competence, but also for the highest devotion to their profession and to the interest of the U.S. Government. They died in the service of their country in its program of providing assistance to the developing countries of the world. Their loss will be keenly felt in both the domestic and oversea programs of the Government."

Mr. Fogarty was a native of North San Juan, Calif., and was an internationally recognized pioneer in developing the economic land classification procedures now used by the Bureau and other agencies in the United States and foreign countries. He received the Department of the Interior's Distinguished Service Award in 1959 for his contributions in this field.

Mr. Fogarty first came to the Bureau in December 1926 as an economist in Denver, following his graduation from the University of California. He also held a master's degree from Oregon State College. His work with the Bureau was chiefly in Denver and Washington, D.C.

Mr. Ferris, whose home was Sturgeon Bay, Wis., had approximately 21 years of Federal service, including military service and employment with the Soil Conservation Service. He had degrees from the University of Wisconsin and Michigan State College.

He had served as a soils technologist on Bureau projects at Great Falls, Mont., Yuma, Ariz., and Klamath Falls, Oreg.; and as a staff member in the Boise, Idaho, regional office. He also spent 4 years on soil and land classification work in Lebanon and several months in Saudi Arabia. He had been at the post in Ethiopia since January 26, 1959.

Medals in memory of the two Bureau employees have been presented to Mrs. Fogarty and Mrs. Ferris by the Imperial Ethiopian Government, which said, "Both of these men have contributed to the development of our country." # # #

New Research in Evaporation

(Continued from page 70)

Blower equipment intake hose is placed in drum of powdered alcohol. Mixture is drawn from drum and blown over water.

tion which can be easily performed in the laboratories.

The fundamental properties of the film-forming materials are being studied to determine their requirements for most efficient evaporation reduction. Special equipment is being employed to study the chemical analysis of various commercial mixtures of hexadecanol, octadecanol, and similar compounds to determine the presence of trace compounds or impurities which may be seriously influencing the ability of the film to reduce reservoir evaporation. The spreading abilities of the various materials are being investigated and the influence of the crystal structure of the fatty alcohol mixture is studied and related to the important properties of the material as an evaporation retardant.

One of the most important phases of the laboratory studies is the research and development of new and improved techniques of applying the film to lake surfaces. This work is to be carefully coordinated with field tests. Tests are also being planned to study the technique of applying film-forming materials from airplanes using methods similar to those for crop dusting and spraying weeds.

A vital part of the laboratory research program is the development of new and improved equipment and techniques for measuring the evaporation savings accomplished by the monolayer during field tests. This part of the study covers not only improvement of the so-called energy budget technique, but also research into new unexplored methods.

Three universities and the Robert A. Taft Sanitary Engineering Center of the U.S. Public Health Service at Cincinnati, Ohio, hold contracts for Bureau-sponsored research under the third phase of the 5-year program. At this writing, negotiations are underway with several other institutions.

Montana State College is carrying out fundamental studies of monomolecular layers. Previously, the college collaborated with the Bureau to investigate the attrition or loss of the layers from stock ponds. The college's current studies include investigation of the physical and chemical processes which contribute to loss of the layers from lake surfaces, such as solution and vaporization of the chemical films and their destruction by ultraviolet light from the sun.

At Arizona State University, a preliminary investigation is being made of the important variables, investigative procedures, and necessary equipment to study the interrelation of wind, water waves, and monomolecular layers. At the completion of this study, a report will be prepared formulating a thorough research program covering this subject.

Colorado State University is evaluating the influence of various evaporation-reducing substances on warm-water fish and other wildlife. This is a continuation of a previous study the university had perfomed under Bureau sponsorship on the effects of hexadecanol on game fish.

The Taft Sanitary Engineering Center, U.S. Public Health Service, scientists are investigating the biological consumption of monomolecular layers and methods of preventing this loss. Tests have indicated that the normal bacteria found in lakes and reservoirs may consume significant quantities of the chemical films. This study is to evaluate the rate at which the bacteria eat the monomolecular layers and chemicals which may be safely added to the films to control the loss. The Taft Center is also investigating possible methods for performing rapid screening tests of evaporation-reducing films.

The results of the program so far and data from previous studies firmly establish that it is physically possible to apply to a large reservoir a one-molecule-thick chemical film which can significantly reduce evaporation. The cost of some

field applications definitely indicates that at least in certain locations the process can ultimately become economically feasible.

However, recent developments reveal that no single material or technique can be devised which will provide the most efficient, economical, and effective means of reducing evaporation at every reservoir. Rather, a collection of various techniques and materials must be developed to provide the selection of the proper technique and the proper material to best suit a particular reservoir and the conditions which prevail there. # # #

Small Project Loans

(Continued from page 60)

New Tunnel Hill Tunnel of Georgetown Divide District is far cry from hard-to-maintain facilities now being replaced.

Construction of Stumpy Meadows Dam is well advanced and will be completed this fall. It is an earthfill structure which will be 162 feet high, 1,400 feet long at the crest, contain 920,000 cubic yards of material, and cost an estimated $1,570,000 to construct. The lake formed by the dam will contain 20,000 acre-feet of water, and the project will yield 15,750 acre-feet per year. Since this lake is located in an inviting timbered mountain area, it is expected to attract heavy fishing and recreational use.

Construction of the diversion dam and El Dorado Canal, to connect with the district's main Georgetown Ditch, are now complete, at a cost of about $1,393,000. The diversion dam is a small concrete structure which diverts reservoir releases from Pilot Creek to the 100-cubic-foot-per-second capacity El Dorado Canal. The canal begins with 5,000 feet of 48-inch concrete pipe laid on a bench cut in the rocky slope of Pilot Creek Canyon. Beyond the pipe the canal is largely in earth section, open and unlined, along steep timbered hillsides until it takes a shortcut, via tunnel, through a ridge to join Georgetown Ditch.

Beyond this junction, Georgetown's existing system must be enlarged, improved, and extended to deliver the increased water supply. Also, there are the small diversion works to be built to increase the yield of Stumpy Meadows Reservoir by adding water from Onion Creek. These jobs, costing about $818,000, are to be financed by the district with revenues from the project.

Altogether, the project is estimated to cost $4,696,000, irrigate about 4,200 acres of land, serve the community of Georgetown, and create substantial recreational benefits. Of the total cost, the Small Reclamation Projects Act is supplying $3,877,670 in the form of a loan, nearly all of it interest free.

Others Under Construction

Considerable interest has been shown in the Small Projects program by many western water user groups. The following are those organizations that have their projects under construction, and there are yet others—as far west as the new State of Hawaii—whose loan applications are in varying stages looking toward eventual initiation of their own projects. One project—that of the South Davis County Water Improvement District in Utah—has been completed with a loan of $558,033.

	Loan (rounded to thousands)
Bountiful Water Subconservancy District, Utah	$3, 510, 000
Browns Valley Irrigation District, California	4, 804, 000
Cameron County Water Control & Improvement District No. 1, Texas	4, 600, 000
Centerville-Deuel Creek Irrigation Co., Utah	402, 000
Donna Irrigation District, Texas	4, 067, 000
Georgetown Divide Public Utility District, California	3, 878, 000
Goleta County Water District, California	2, 080, 000
Pleasant Valley County Water District, California	2, 040, 000
San Benito County Water Conservation & Flood Control District, California	1, 425, 000
Santa Ynez River Water Conservation District, California	3, 800, 000
South San Joaquin Irrigation District, California	4, 900, 000
South Sutter Water District, California	4, 876, 000
Walker River Irrigation District, Nevada	[1] 693, 000

[1] Includes flood control grant of $130,000.

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5420	Missouri River Basin, Iowa-S. Dak.	Apr. 7	Furnishing and installing a multichannel microwave radio communication system between Watertown, Huron, and Fort Thompson substations; Oahe and Fort Randall powerplants; Huron Project Office; and Wessington Springs VHF, radio station.	General Electric Co., Denver, Colo.	$643,000
DC-5476	Colorado River Storage, Colo	Apr 24	Construction of 115 miles of Rangely-Oak Creek and 10 miles of Kremmling-Green Mountain 115-kv transmission lines and 8.3 miles of Kremmling-Gore tap 69-kv transmission line.	Wasatch Line Construction Co., Salt Lake City, Utah.	1,809,720
DS-5496A	Central Valley, Calif	May 3	9 230-kv power circuit breakers for Keswick switchyard.	Federal Pacific Electric Co., Santa Clara, Calif.	410,629
DC-5507	Collbran, Colo	June 7	Construction of earthwork and structures for East Fork diversion dam and East Fork feeder canal, and rehabilitation of Bonham Dam.	Theo Wood Construction Co., Salt Lake City, Utah.	258,694
DC-5510	Missouri River Basin, Mont.-Wyo.	Apr. 28	Construction of administration building, garage and fire station, field laboratory building, 12-car garage, and comfort station for Yellowtail community facilities, Schedules 1, 2, 3, 4, and 5.	COP Construction Co., Billings, Mont.	170,646
DS-5513	Missouri River Basin, Nebr	Apr. 18	Construction of earthwork, structures, and surfacing for St. Ann and Spring Creek road relocations.	Lawrence Heide Contractor, Smith Center, Kans.	232,108
DC-5515	Missouri River Basin, Iowa-N. Dak.	Apr. 4	Construction of stage 04 additions to Sioux City substation and additions to Grand Forks substation.	Gustav Hirsch Organization Inc., Columbus, Ohio.	480,805
DC-5516	Missouri River Basin, Kansas	Apr. 21	Construction of earthwork and structures, Cedar Bluff canal, Station 211+44.6 to 569+00.	Ark Valley Construction Co., Wichita, Kans.	514,545
DC-5520	Smith Fork, Colo	Apr. 4	Construction of earthwork and structures for Aspen Canal, Sta. 0+63.5 to 73+08.5, utilizing pretensioned concrete pipe for Smith Fork siphon, Schedule 2.	Bud King Construction Co., Missoula, Mont.	283,873
DS-5521	Colorado River Storage, Ariz.-Utah.	do	1 165-ton gantry crane for Glen Canyon Dam	Pacific Coast Engineering Co., Alameda, Calif.	183,500
DS-5522	Colorado River Storage, Ariz.-Utah.	Apr. 21	Furnishing and installing 8 125,000-kva generators for Glen Canyon powerplant.	General Electric Co., Denver, Colo.	8,007,798
DC-5525	Missouri River Basin, Mont.-Wyo.	Apr. 24	Construction of Yellowtail Dam and powerplant	Morrison-Knudsen Co., Inc., the Kaiser Co., Perini Corp., Walsh Construction Co., and F. and S. Contracting Co., Boise, Idaho.	39,809,359
DC-5526	Missouri River Basin, S. Dak.-Minn.	May 29	Stringing conductors for second circuit additions for 74.23 miles of Watertown-Granite Falls 230-kv transmission line.	Kehne Electric Co., Inc., St. Paul, Minn.	656,951
DC-5534	Missouri River Basin, S. Dak	Apr. 19	Stringing conductors and overhead ground wires for 58 miles of Oahe-Fort Thompson 230-kv transmission line, 230-kv Oahe switchyard approaches, and 1.42 miles of 115-kv Oahe-Midland Transmission line.	Martin Engineering Co., Pelican Rapids, Minn.	1,166,473
DS-5539	Central Valley, Calif	May 9	3 35,000/46,667/58, 333-kva power transformers with lightning arresters for Clear Creek powerplant.	Wagner Electric Corp., St. Louis, Mo.	345,027
DC-5541	Chief Joseph Dam, Wash	May 10	Construction of earthwork, pipelines and structures, including 3 pumping plants and 2 regulating reservoirs, for laterals 1 through 10 and sublaterals, East Unit lateral system.	Frank Coluccio, Construction Co., Seattle, Wash.	1,398,236
DC-5548	Lower Rio Grande Rehabilitation, Texas.	May 11	Construction of earthwork, concrete lining, and structures for rehabilitation of 13.0 lateral system.	K. F. Hunt Contractor, Inc., and H. and H. Concrete Construction Co., Corpus Christi, Tex.	464,973
DS-5559	Weber Basin, Utah	June 16	3 vertical-shaft, centrifugal or mixed-flow type pumping units for Willard pumping plant No. 1, Schedule 1.	Fairbanks, Morse & Co., Chicago, Ill.	189,254
DS-5562	Colorado River Storage, Ariz.-Utah.	June 5	8 governors for turbines for Glen Canyon powerplant.	Baldwin-Lima Hamilton Corp., Pelton Division, San Francisco, Calif.	379,250
DC-5563	Central Valley, Calif	June 22	Construction of Spring Creek debris dam	Gibbons and Reed Co., Salt Lake City, Utah.	3,196,387
DC-5566	San Angelo, Tex	May 24	Construction of earthwork, concrete lining, and structures for Main canal, Sta. 0+00 to 838+59.	H. B. Zachry Co., San Antonio, Tex.	1,487,494
DC-5570	Seedskadee, Wyo	June 13	Construction of Fontenelle Dam	Foley Brothers, Inc., and Holland Construction Co., St. Paul, Minn.	7,917,170
DS-5577	Colorado River Storage, Ariz.-Utah.	June 21	8 13.96-foot by 22.45-foot fixed-wheel gates for penstock intakes at Glen Canyon Dam.	Vereinigte Osterreichische Eisen- und Stahlwerke A. B. Linz/-Donau, Austria.	601,600
DS-5580	Missouri River Basin, N. Dak	June 9	567,000 linear feet of 954 MCM aluminum cable, steel-reinforced conductor for Garrison-Jamestown 230-kv transmission line, Schedule 1.	Kaiser Aluminum & Chemical Sales, Inc., Oakland, Calif.	205,254
DS-5580	Missouri River Basin, N. Dak	June 21	1,700,000 linear feet of aluminum cable, steel reinforced conductor, 1,134,000 linear feet of ½-inch steel strand, 280 compression dead-end assemblies, 960 compression joints, and 275 compression repair sleeves for Garrison-Jamestown 230-kv transmission line, Schedules 1 and 2 (set aside portions for labor surplus area firms) and Schedule 5.	Southwire Co., Carrollton, Ga	720,286
400C-162	Provo River, Utah	Apr. 25	Construction of earthwork and structures for Provo River channel revision, Mile 29.8 to 34, below Duchesne tunnel.	E. V. Chettle, Salt Lake City, Utah.	270,621
400C-170	Seedskadee, Wyo	June 19	Construction of administration building; fire station, shop, and laboratory building; warehouse; 1 10-stall and 4 4-stall garages; and utility building for Fontenelle government community.	Witt Construction Co., Provo, Utah.	170,190
500C-90	Washita Basin, Okla	Apr. 13	Construction of Foss reservoir recreational facilities	Ray W. Lynch, Contractor, Oklahoma City, Okla.	182,338
500S-95	Lower Rio Grande Rehabilitation, Texas.	Mar. 24	Approximately 108,000 linear feet of unreinforced and reinforced concrete pressure pipe and 800 linear feet of concrete culvert pipe for Hidalgo and Cameron Counties Water Control and Improvement District No. 9.	W. T. Liston Co., Harlingen, Tex.	409,362

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Major Construction and Materials for which Bids will be Requested through August 1961 *

Project	Description of work or material
Central Valley, Calif	Constructing the Trinity-Clear Creek, Clear Creek-Keswick, and spring Creek-Keswick Transmission Lines will consist of clearing rights-of-way, constructing footings, erecting Government-furnished steel towers, and stringing Government-furnished 795, 954, and 1,272 MCM, ACSR conductors, and 0.5-inch steel overhead ground wires for about 16 miles of 230-kv, single-circuit, and about 12 miles of 230-kv, double-circuit line. Northwest of Redding.
Do	Completing the Trinity and Spring Creek powerplants and the Clear Creek powerplant and switchyard will consist of: *Trinity powerplant.*—Installing penstocks and 2 butterfly valves; backfill, grading, drainage, and surfacing access area; placing concrete for turbine embedment and generator support; installing 2 70,000-hp reaction turbines, and an a-c transformer bank and other electrical and mechanical equipment; constructing interior masonry wall partitions; and installing architectural features. *Spring Creek powerplant.*—Grading and surfacing powerplant service yard; placing concrete for turbine embedment and generator support; installing 2 105,000-hp reaction turbines, an a-c transformer bank and other electrical and mechanical equipment; constructing interior masonry wall partitions; and installing architectural features. *Clear Creek powerplant and switchyard.*—Grading, drainage, and surfacing the access area; placing concrete for turbine embedment and generator support; installing 2 93,500-hp reaction turbines, an a-c transformer bank and other electrical and mechanical equipment; constructing interior masonry wall partitions; and installing architectural features. Completion work for switchyard will consist of constructing concrete foundations, furnishing and erecting steel structures, installing electrical equipment, major items of which will be Government-furnished; and surfacing and fencing the area.
Do	Constructing about 32 miles of 8- to 30-inch diameter pipelines. Alternate bids will be requested for pretensioned concrete cylinder pipe, noncylinder prestressed concrete pipe, asbestos-cement pipe, and mortar-lines and coated steel pipe. Work will also include constructing 7 earth-lined reservoirs and 2 concrete-lined reservoirs. El Dorado pipelines, Contract Units 2 and 3, near Placerville.
Do	Treatment plants for Reservoirs No. 1 and 7, El Dorado Distribution System. Reservoir No. 1—Constructing a 22-by 26-foot building and a 10- by 12-foot building, both of reinforced-concrete masonry units; a reinforced-concrete 2-compartment mechanical mixer and flocculator tank with an approximate area of 1,250 square feet; a reinforced-concrete transition with an approximate area of 2,400 square feet from the tank to the reservoir; and installing water treatment equipment. Reservoir No. 7—Constructing a 24- by 32-foot building of reinforced-concrete masonry units and installing chlorination equipment. Northwest of Sacramento.
CRSP, Ariz.-N. Mex	Constructing the Glen Canyon-Shiprock 230-kv Transmission Line will consist of clearing right-of-way, constructing footings, furnishing and erecting 175 miles of steel towers and stringing 3 Government-furnished 1,272 MCM (45/7) ACSR conductors and 2 0.5-inch galvanized steel strand overhead ground wires for 182 miles of single-circuit line. From Glen Canyon Dam to a point about 12.5 miles northwest of Shiprock, N. Mex.
CRSP, Utah	2 16.75- by 34-foot fixed-wheel gates for spillway intake structure at Flaming Gorge Dam. Estimated weight: 175,000 pounds.
Grand Valley, Colo	Work will include excavating open cut at outlet portal of Tunnel No. 3, about 75 feet back from existing portal, removing a portion of the existing tunnel outlet structure, constructing about 130 linear feet of reinforced-concrete conduit at new outlet portal, and constructing a new outlet structure; removing about 250 linear feet of the Stub Ditch discharge line and constructing about 800 linear feet of precast-concrete pipeline for the ditch; removing about 130 linear feet of the outlet leg of the Colorado River siphon, which has 12-inch-thick reinforced-concrete walls, and placing 130 linear feet of 108-inch-diameter precast-concrete pipe in the siphon, and relocating about 1,250 linear feet of concrete bench flume, 17 feet wide and 8 feet high, requiring about 250,000 cubic yards of excavation. Near Palisades.
Klamath, Calif	Constructing the outdoor-type Tule Lake Division No. 10 and 11 pumping plants with wood superstructures set on wood piling and installing 2 25- and 3 30-cfs pump units with steel discharge pipes for each pump terminating in a concrete outlet structure. South of Tulelake.
Do	Constructing about 2 miles of laterals and rehabilitating about 10 miles of existing laterals with capacities of from 40 to 20 cfs; rehabilitating about 21 miles of existing drains to about 7 feet deep with bottom widths up to 10 feet. Sump 3, Contract 2, near Tulelake.
Lower Rio Grande Rehabilitation, Tex.	Rehabilitating about 5 miles of Lateral 6.0 will consist of reshaping the prism and banks, constructing unreinforced-concrete lining in the reshaped prism, with bottom widths of 3 and 5 feet, and constructing about 1.6 miles of 36-inch-diameter concrete pipelines. Near Harlingen.
MRBP, Kans	Earthwork, structures, and trackwork for about 10 miles of Chicago, Rock Island, and Pacific Railroad around the reservoir to be created by Norton Dam. Near Norton.
MRBP, Mont	Constructing Clark Canyon Dam, a 1,900,000-cubic-yard earthfill structure, 135 feet high and 2,900 feet long, with outlet works and spillway; and relocating about 1.5 miles of county road. On Beaverhead River, about 20 miles southwest of Dillon.
Do	Constructing the Barratts Diversion Dam will consist of a reinforced-concrete spillway with a 24- by 10-foot radial gate, a sluiceway with an 8- by 10-foot radial gate, 2 radial-gate controlled headworks structures and earth dikes; constructing about 20.5 miles of the East Bench Canal and about 4 miles of laterals. Near Dillon.
Do	2 125-ton-capacity overhead traveling bridge cranes for Yellowtail powerplant. Estimated weight: 280,000 pounds.
MRBP, Nebr	Earthwork and structures for about 9 miles of the 10-foot bottom width Red Willow Canal (first section). Near McCook.
Do	Earthwork and structures for about 7.7 miles of 9-foot bottom width canal, concrete-lined with height of lining 8.4 feet. Ainsworth Canal, near Valentine.
Do	Constructing 1 2-bedroom wood-frame residence with full basement; 1 24- by 48-foot timber-frame laboratory and garage building; 1 2-stall prefabricated metal combination shop and storage shed, complete with water, sewerage, and electrical systems; and furnishing and erecting 590 linear feet of single-phase, 3-wire, 115/230-volt, solid neutral powerline. About 25 miles southwest of Valentine.
Do	Additions to the Chadron substation will consist of constructing a 21- by 33-foot concrete masonry unit service building and concrete foundations, furnishing and erecting steel structures, installing a 115-kv circuit breaker and other associated electrical equipment, major items of which will be Government-furnished.
San Angelo, Tex	Earthwork and structures for about 35 miles of concrete-lined open laterals. Near San Angelo.
Uncompahgre, Colo	Constructing a new reinforced-concrete headworks structure with 3 10-foot radial gates; adding 1 24-foot radial-gate-controlled reinforced-concrete structure to an existing diversion dam in the Uncompahgre River. Work will also include constructing about 800 linear feet of 350-cfs-capacity Ironstone Canal. Near Montrose.

*Subject to change.

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What's Coming:

Golden State's Golden Plan

CRSP Participating Projects

Official Publication of the Bureau of Reclamation

Reclamation ERA

GOLDEN STATE'S GOLDEN PLAN

NOVEMBER 1961

The Reclamation Era

NOVEMBER 1961 **VOLUME 47, NO. 4**

In this issue . . .

VIOLET PALMER, Editor
THEODORE R. McCANN, Art Editor

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golden state's golden plan

by **WILLIAM E. WARNE, Director, California Department of Water Resources**

When the voters of California approved the Burns-Porter Act in November 1960, they gave their blessing to one of the largest single water development projects in the history of the world.

The voters approved a $1.75 billion general obligation bond issue which, together with tidelands oil revenue, will build a system of dams, reservoirs, canals, tunnels, and pumping plants to transfer surplus water from the Feather River and the Sacramento-San Joaquin Delta to areas of need near San Francisco Bay and in central and southern California.

The system, together with the vast complex of the Central Valley Federal reclamation project with which it will be coordinated, will be another major step in meeting the needs of the future in the Golden State.

Key feature of the system will be the 735-foot-high zoned-fill embankment "Big Oroville" Dam, to be built on the Feather River about 5 miles northeast of the city of Oroville. The crest of the dam will be more than a mile long, and an estimated 80,000,000 cubic yards of material will be required to complete it. The reservoir to be backed up by the dam will store 3,500,000 acre-feet of water, and the resultant shoreline will be 167 miles. The surface area is estimated at 15,500 acres. There will be recreational areas around the lake, and storage for conservation and flood control will be provided. The Federal Flood Control Act of 1958 authorizes a Federal monetary contribution based on flood control benefits and operations of Oroville Dam and reservoir.

Inside one of the rock abutments will be a 600,000-kilowatt powerplant. Three of the six power generating units to be installed will be pump-storage type, with the units serving a dual role as generators and pumps. They also will provide a higher energy output without decreasing water yield.

About 27 miles of rail lines are presently being relocated around the reservoir site, as are more than 20 miles of U.S. Highway 40–A from Oroville to Jarbo Gap. This work, including five railroad tunnels totaling about 4 miles in length, is due for completion in the coming months, at

which time work on the dam embankment will begin (probably early in 1962). Construction of the diversion tunnel began during the summer and the dam itself should be completed in 1968.

Farther up the Feather River, high in the Plumas County Sierra, five smaller dams and reservoirs are authorized. The first of these, Frenchman, is to be completed this year. Work is due to begin in 1962 on the second one, Antelope Valley Dam and reservoir. In subsequent years, construction of the remaining three—Grizzly Valley, Abbey Bridge, and Dixie Refuge Dams and reservoirs—will be scheduled, although not necessarily in that order.

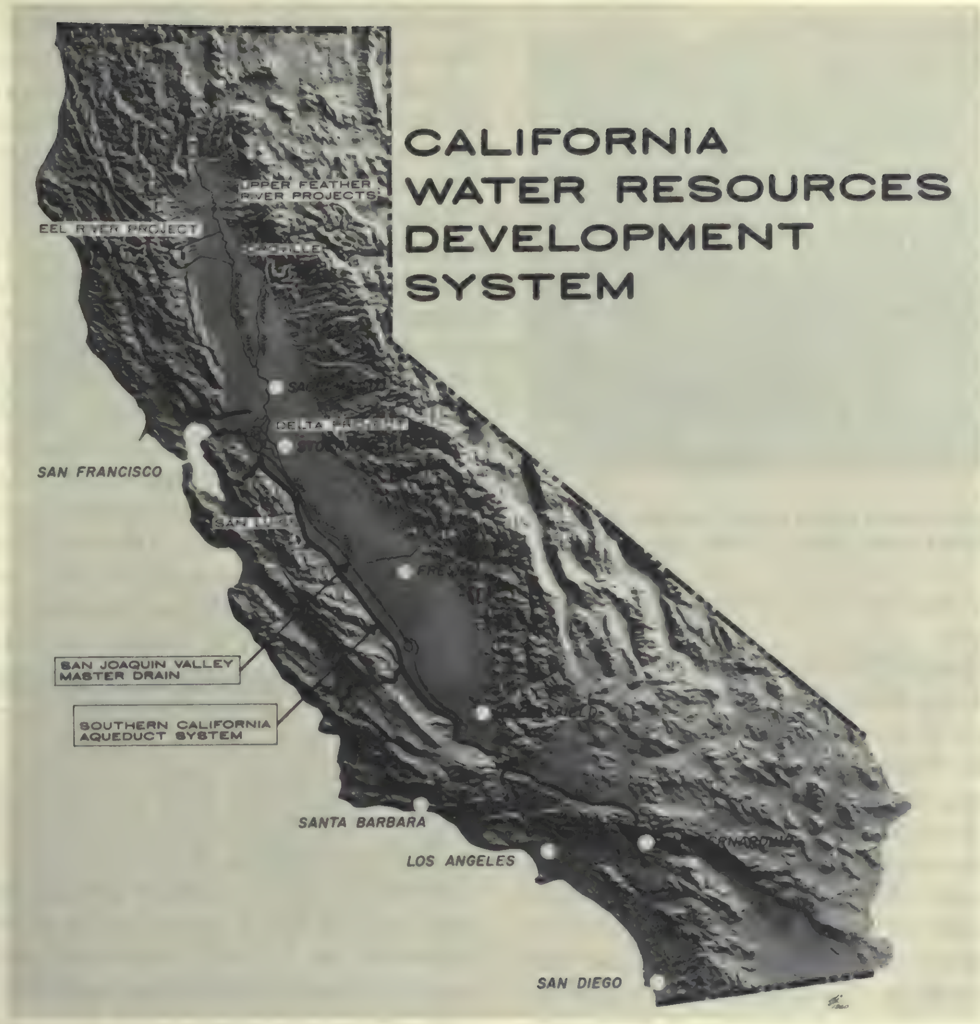
The average capacities of these reservoirs, which are authorized to be built for recreation enhancement and for incidental downstream flood protection, are about 35,000 acre-feet. Their combined capacities total about one-twentieth the capacity of Oroville Reservoir. These facilities will serve irrigation in Sierra Valley, streamflow maintenance and recreation.

When water begins pouring forth from "Big Oroville" for use downstream, it will continue in the Feather River, serving irrigation needs en route, until its juncture with the Sacramento River near Marysville, where it will commingle with waters from the Bureau of Reclamation's Shasta Dam and Trinity Division of the Central Valley project.

Proceeding southward, this water will flow into the Sacramento-San Joaquin Delta, which is the heart of the entire California water project.

The true delta, sometimes called the delta "lowlands," covers about 700 square miles and consists of a patchwork of 50 islands and 1,100 miles of waterways. Most of these islands are below sea level, and protection to the valuable farmlands is

Key feature of California's water plan will be Oroville Dam to be constructed on the Feather River, shown here near Oroville, Calif.



now afforded by individual levee systems along the channels.

The delta water facilities will be the focal point of statewide transfer of water supplies. These facilities are planned for two main purposes: (1) as a solution to the delta's present problems of flooding, subsidence, and salinity intrusion, and (2) to salvage and convey northern water to other parts of the State without waste or deterioration in quality. The delta is a prime agricultural and recreation area.

One of the State's proposed aqueducts, the South Bay Aqueduct, would carry water from this region to the counties of Alameda, Contra Costa, and Santa Clara. Farther north, the North Bay Aqueduct would conduct water to the counties of Solano, Napa, Sonoma, and Marin. These will serve many cities and urban areas and provide some irrigation.

South of the delta, on the west side of the San Joaquin Valley, the State and the Bureau of Reclamation have commenced advance planning work on the joint-use San Luis project. Authorization by the Congress of the San Luis Unit of the Bureau's Central Valley project (S. 44, June 3, 1960) was a trail-blazing step in Federal-State relations. The legislation provides a framework whereby the Federal Government and the State of California may collaborate in constructing and operating certain features to jointly serve both the Federal project and the State's water development program.

Development of the San Luis Unit will consist of an earthfill dam providing a 2,100,000-acre-foot reservoir 12 miles west of Los Banos, the San Luis forebay regulating reservoir, pump-generating plant, and a joint-use aqueduct running 100 miles from the reservoir to Kettleman City in Kings County. These works will be constructed by the Bureau of Reclamation with the costs of

Rail lines are being relocated around Oroville Reservoir site. This is North Fork railroad bridge about 15 miles north of Oroville.

construction being equitably shared by the State and the Bureau.

From Kettleman City the State's aqueduct system will continue south into southern California, with branches to the coastal area and over the Tehachapi Mountains. The State will build its own canal from the delta to San Luis Reservoir.

From San Luis, the State's California Aqueduct will make water available to Fresno, Tulare, Kings, Kern, Los Angeles, Ventura, San Bernardino, Riverside, Orange, San Diego, San Luis Obispo, Monterey, and Santa Barbara Counties. This stretch will be the longest of the approximately 750 miles of aqueducts that are authorized as part of the State facilities. It is estimated that 21,000,000 people will be in this aqueduct's service area by 1985, with 7,800,000 of them expected to receive project water in that year.

All told, the State facilities will move about 4 million acre-feet of water annually by the peak demand year of 1990. In addition to this, local projects built with $130,000,000 of Davis-Grunsky Act funds (California Aid to Local Projects Act) will increase the annual total of water conserved and distributed by means of the State water project.

Even such a great amount of water will not be sufficient to the needs of all Californians for generations to come.

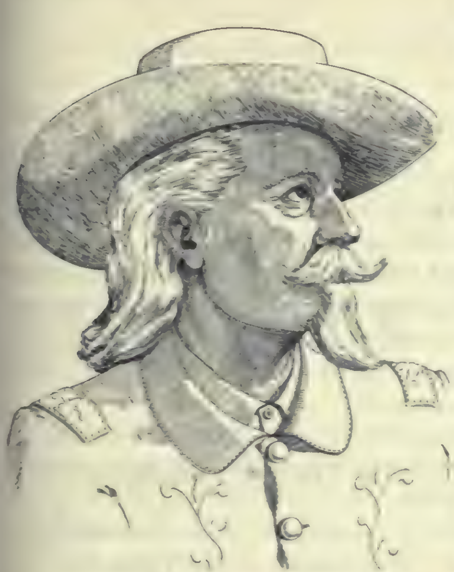
The department of water resources has continually stressed that the only way the State will have truly adequate water development is for *all* levels of government—State, Federal, and local—to work in their respective fields of responsibility, coordinating their activities wherever possible. No single agency can, alone, bring about maximum water resource development in a State as large and under so great a population pressure as California, if the varying and urgent needs of her citizens are to be met in time.

With this in mind, the department joined with the Bureau of Reclamation on May 16, 1960, in reaching a milestone in State-Federal relationships. It was on that day an agreement was signed paving the way for coordinated operation of California's two gigantic water systems—the Bureau's Central Valley project, and the State's Feather River and Delta Diversion projects.

It had long been recognized that operation of all water resources development projects which use the Sacramento-San Joaquin River Delta as a point of diversion, must be fully coordinated. The agreement, which was signed in the offices of Governor Edmund G. Brown, provides that the two agencies can satisfy, within certain limits, the water needs of their respective service areas throughout the State. It also provides for a pro-rata apportionment of the water to the various service areas in the event of a short water year.

With the signing of this agreement, and with construction of the State water project facilities now moving ahead, it is clear that California is embarked on a highly ambitious—and urgently needed— water development program. With this year being the State's third dry one in a row, these new facilities cannot come a year, or even a month, too soon. # # #

Highway 40—A relocation at Table Top Mountain is part of preparation. *(California Department of Water Resources photos.)*



OLD PIONEER GETS NEW LEASE ON LIFE

by FRED A. ANDERSON [1]

Rugged! That's the word used by veteran construction men to describe the job of rehabilitating Buffalo Bill Dam. Treacherously steep canyon walls, the bitter winters of northern Wyoming, and the fact that the dam was to remain in service during construction added up to headaches for the contractor.

Buffalo Bill Dam is the controlling feature of the Shoshone project irrigation system in the Big Horn Basin of Wyoming. The dam, on the Shoshone River, west of Cody, Wyo., was one of the Reclamation Service's earliest dams. It was completed in 1910 and, at that time, was the tallest dam in the world and the only one whose height exceeded its width.

Originally named Shoshone Dam, its name was changed in 1946 to Buffalo Bill Dam in honor of the famous frontiersman, William F. Cody. Buffalo Bill had, early in the century, recognized the possibilities for irrigation in this area and was largely responsible for some of the canals along the Shoshone River and the development of the area around Cody.

After nearly a half-century of service, major rehabilitation to the dam became necessary to remedy conditions which were beginning to limit its usefulness. Sediment and debris on the reservoir bottom prompted the work. Rocks are continually rolling down the canyon walls into the reservoir to add to the silt accumulation.

Early designers placed the intakes for both the outlet works and the power penstocks near the bottom of the reservoir. The outlets regulate releases of water for irrigation and other purposes, and the penstocks supply water to the 5,600-kilowatt Shoshone Powerplant. In later years accumulated silt and debris became a problem and threatened to clog both penstocks and outlet works.

As part of the 5-year rehabilitation program, a new outlet works tunnel was bored in the left canyon wall rather than attempting to rehabilitate the old, debris-clogged outlet tunnel in the right canyon wall.

The contractor, Long Construction Co., Billings, Mont., began boring the tunnel downstream from the dam and continued up and around the dam until his crews were within 40 feet of breaking through into the reservoir. At this point, forward movement was stopped. After the irrigation season, the reservoir was drawn down to the level of the floor of the upstream portal.

The reservoir froze and the contractor lowered a tractor to the ice so the remaining 40 feet of

[1] Prepared by Mr. Anderson during assignment to Bureau's Denver Technical Information Branch as participant in engineer rotation training program.

rock could be blasted through, using the tractor to clear debris.

After the tunnel was holed through, the weather turned mild unexpectedly and the ice on the reservoir began to soften. Despite frantic efforts on the part of the contractor, the tractor broke through and sank more than 100 feet to the bottom. All attempts at recovery proved unsuccessful. The new outlet tunnel was completed by the end of the summer of 1959, despite the lost tractor and rugged conditions.

Rehabilitating the penstocks proved to be the toughest part of the job. The contractor was instructed to place two vertical extensions over the intakes so that water would be taken from the reservoir above the silt accumulation. Each of these extensions was a steel "can" 28 feet high by 8 feet in diameter, weighing 17,000 pounds and they had to be placed in water up to 150 feet deep. Placing was begun in March 1959 when there was still ice on the reservoir. The "cans" were to be lowered from an overhead cableway which ran across the canyon above the dam. Each was to be guided into place by divers.

The lowering took place without incident and the diver reported that the "cans" were in place. However, another inspection about a month later proved that both had shifted and were several feet out of position.

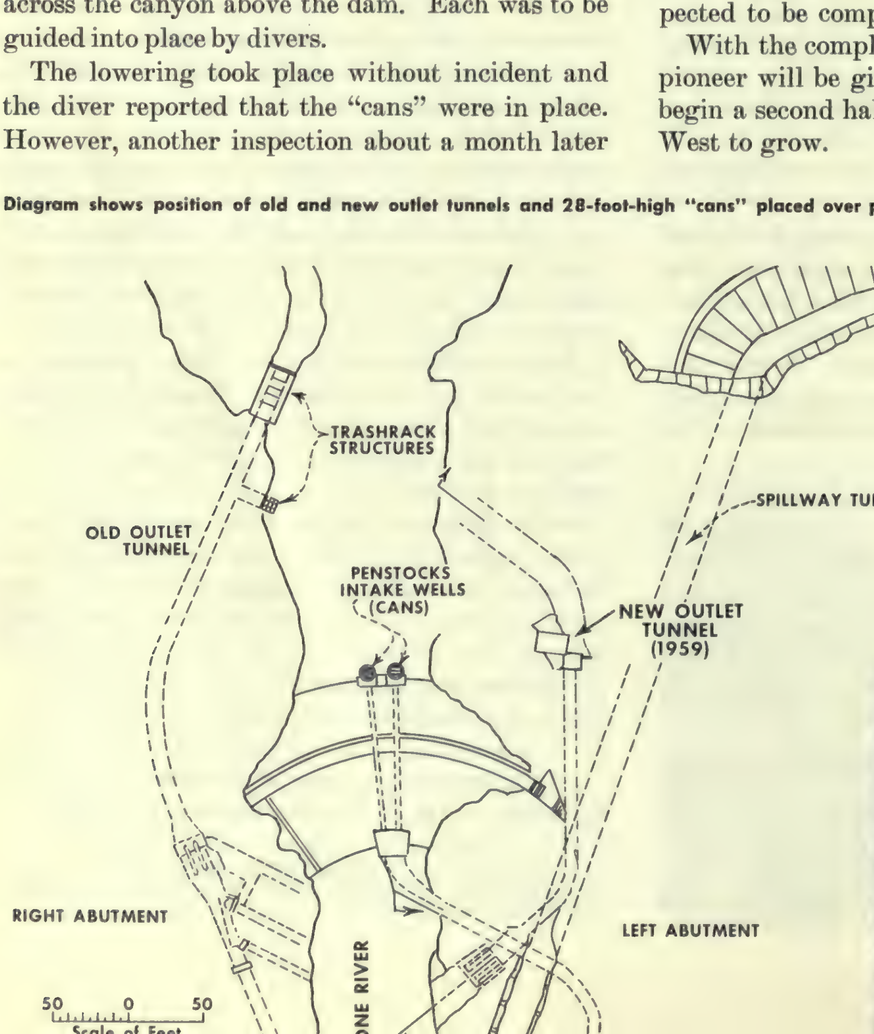
The use of divers was the only solution, since the water had to be retained in the reservoir to irrigate the valuable cropland downstream. In late April, a crew of divers began attempts to reposition the "cans." This task was performed under the most adverse conditions on the job. The divers were working in freezing water up to 150 feet deep, and most of the time could not see because of blinding clouds of silt stirred up by their own movements. It was late in July 1959 before the divers finally were able to report that the job was completed.

The penstocks and outlet works have been in operation for over 2 years now and have shown no signs of trouble.

Work is now underway to plug with concrete the old outlet works tunnel in the right wall of the canyon. To prepare for placement of the plug, leakage through old tunnel control gates was reduced by pumping concrete into the tunnel behind the gates. Work on the tunnel plug is expected to be completed this construction season.

With the completion of the tunnel plug, the old pioneer will be given a new lease on life and will begin a second half-century of service helping the West to grow. # # #

Diagram shows position of old and new outlet tunnels and 28-foot-high "cans" placed over penstock intakes to avoid silt and debris.



epoxy resins

NEW AIDS FOR WATER USERS

by CARL E. SELANDER [1]

Epoxy resins, remarkable new construction and maintenance materials, are under intensive investigation by research engineers in the Bureau of Reclamation's Engineering Laboratories in Denver for a variety of applications on Reclamation projects. The resins, important products of the plastics industry, have skyrocketed into prominence in recent years because of their many valuable properties which water users can utilize in a thousand and one ways.

Because of the unique chemical makeup of epoxy resins, they may be applied as adhesives having high tensile and shear strengths, as tenacious fillers for repairing cracked surfaces of concrete and other materials, and as durable protective coatings for many purposes.

What are epoxy resins? They are thermosetting plastics—plastics which are originally liquid (some are solid) and are then hardened by a chemical crosslinking induced by heat, pressure, and/or chemical reaction; they cannot be resoftened or liquefied by subsequent application of heat.

Epoxy resin materials are generally supplied in two components. One is the resin and the other is a chemical called a "curing agent." When the curing agent is added to the resin, a chemical reaction takes place—the molecules of the resin link, forming the final product.

Manufacturers supply epoxy resins having different physical characteristics for a variety of applications. The resins may range from thin liquids to heavy pastes. The physical properties of the "cured" resins are also variable and may range from soft, elastic compounds to those which are extremely hard or brittle. Proper selection of the epoxy materials and precise proportioning are necessary to obtain the desired results.

Because of their excellent adhesive properties, epoxy resins are being successfully used as bonding agents in a large number of applications. Metals, plastics, wood, glass, concrete, rubbers, ceramics, masonry units, and other materials can be bonded together. The bonds may be between similar materials, such as metal to metal, or between dissimilar materials, such as metal to concrete. Because they have excellent electrical insulation properties, epoxy resins are being used for insulation, splicing, and as chemical and moisture resistant coatings on electrical appliances and equipment.

Certain epoxy resins, having low shrinkage and high strengths, are utilized to advantage in glass-reinforced products, such as pipe, structural members, and sheeting. Small equipment shelters, sheds, and guardrails are now fabricated from glass-reinforced epoxy resins.

Reclamation researchers have shown that other epoxy resin compounds are applicable to bond fresh new mortar or concrete to hardened concrete. The majority of the compounds for this application are combined with a so-called "modifier" or "alloying" compound.

To bond fresh new mortar or concrete to old concrete, a film of the mixed resin compound is first applied to the cleaned old concrete to the extent of 150 to 200 square feet per gallon; then the fresh mortar or concrete is placed over (or in contact with) the epoxy bond layer while still tacky, vibrated for compaction, and finished as desired. The new mortar or concrete is then cured following usual construction practice.

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[1] Head, Control and Plastic Materials Unit, Division of Engineering Laboratories, Office of Assistant Commissioner and Chief Engineer, Denver, Colo.

Bureau engineers observe lab-tested concrete beam. Epoxy resin cemented joint, being pointed out, proved stronger than original.

Bond strength develops as the resin and mortar cure simultaneously, and becomes high in a relatively short time. Epoxy bonded cement mortar is particularly applicable to "featheredge" repairs, eliminating the need for chipping to obtain thicker concrete at edges, common to conventional repair techniques.

Epoxy compounds also are applicable to bonding hardened concrete to hardened concrete. These compounds are similar to those used for new-to-old bonding, except that for some applications where flow must be restricted, more viscous compounds are used. With these epoxies, broken concrete can be repaired, or precast units such as concrete blocks can be bonded together.

It is possible to fabricate pipe Y's, T's, and other fittings from straight sections of nonmetallic pipe which are cut to fit and then bonded together. Small diameter concrete pipe and clay sewer pipe fittings have been fabricated in this way. These compounds are also useful in repairing cracked concrete where fairly large cracks, which have become stabilized (are not enlarging), can be filled.

Epoxy compounds are also useful in fabricating epoxy mortars or concretes wherein the resin, when filled with graded aggregates (sand and gravel), acts as the binder in the mixture. For epoxy mortars, up to about four parts by weight of graded sand are blended into one part by weight of mixed resin.

For epoxy concretes, as high as 10 parts by weight of graded aggregates are blended into 1 part of mixed resin. These mixtures are useful in repairing eroded or damaged areas, as floor toppings, as grout, as chemical resistant linings, and for a variety of other applications.

Epoxy resin compounds are also applied as antiskid coatings and as moisture barriers. "Do-it-yourselfers" find epoxies useful as adhesives and as fillers for minor repairs. For such uses, there are available the two-tube packages of epoxies marketed in many retail stores—one tube contains the resin, the other the curing agent.

The cost of epoxy resins varies considerably. Bureau researchers have experimented with materials ranging in price from $9 per gallon unit to as much as $48 per gallon unit.

Preparation of surfaces before application of the epoxies is important. Clean, dry surfaces are necessary to obtain optimum adhesion, although some epoxies, particularly for concrete work, will tolerate a degree of dampness if complete drying is not possible or practical. An acid etch or chemical pretreatment, followed by thorough rinsing with clean water, are recommended preliminaries.

The cleaned surface should be allowed to dry before application of the epoxy compound. If acid etching is not practical, sandblast cleaning sometimes may be used, but the final bond strength of the compound will be slightly less. Complete removal of the blasting dust, either by rinsing or by compressed air or vacuum, is necessary to obtain good bond.

One word of caution—because of the chemical nature of epoxy resins, their use requires the exercise of certain safety measures. Some of the resins are irritants which can cause local injury, such as a burn, on short exposure. More importantly, most of the curing agents, in addition to being irritants, are allergens or sensitizing agents from which hypersensitivity can develop. To avoid injury from use of epoxy resins, four basic safety measures must be observed. These are:

1. Prevention of skin contact.
2. Adequate ventilation.
3. Good housekeeping.
4. Personal hygiene.

If these four basic safety measures are followed, incidents of irritation or hypersensitivity should not occur. The exception would be the rare person with chronic sensitivity to epoxy resins. Such a person should avoid any contact with them. # # #

WORKSHOP FOR IRRIGATION OPERATORS

In order to bring the major points of the workshop to the greatest number of people, the Era *will carry a series of four articles on the workshop discussions in the quarterly issues of 1962, beginning with the February issue.*

Eighty representatives from irrigation districts on Reclamation projects have been invited to convene next month in the Denver offices of the Bureau of Reclamation at the Denver Federal Center to participate in a workshop on irrigation operation and maintenance practices and developments.

This year's workshop is being held for representatives from the 11 northern Reclamation States, as climatic conditions in their operating areas are more nearly similar. A future workshop is planned for representatives from irrigation districts of the six southern States of the Reclamation West.

Participants in the intensive week-long workshop will discuss seven broad technical subjects—water management, concrete placement and repair practices, earth construction practices, protective coatings, weed control, equipment management, and pump maintenance.

The conferees are directly responsible for the technical details of operating and maintaining more than 4.5 million acres of irrigated land.

They will participate in roundtable discussions during the week of December 11–15 on techniques in irrigation operation and maintenance.

Group leaders will include 10 engineers from the Bureau's engineering offices in Denver—Wesley W. Beck, Head, Pumping Plant Design Group; Harold J. Gibbs, Head, Special Investigations and Research Section; Elmo C. Higginson, Chief, Concrete Laboratory Branch; Wesley G. Holtz, Chief, Earth Laboratory Branch; Howard S. Latham, Chief Safety Engineer; Paul W. Lewis, Head, Protective Coatings Laboratory Section; Leonard J. Mitchell, Head, General Properties Unit; Alvin J. Peterka, Head, Hydraulic Investigations Section; Arthur A. Wagner, Head, Physical Properties Testing Section; and George B. Wallace, Head, Concrete Materials and Structural Section.


PAUL L. HOUSE


ROBERT M. FAGERBERG


EDGAR H. NEAL


ELMO C. HIGGINSON


DELBERT D. SUGGS


WESLEY G. HOLTZ

Also five specialists from Bureau field offices—Winston H. Hedges, McCook, Nebr.; Lyle H. McIntosh, Loveland, Colo.; Edgar H. Neal, Ephrata, Wash.; Glenn H. Simmons, Burley, Idaho; and Delbert D. Suggs, Ephrata, Wash.

Also two irrigation district managers—Robert M. Fagerberg, Powell, Wyo., and Paul L. House, Nyssa, Oreg.

# # #

Water Control on the Farm

by TYLER H. QUACKENBUSH,
Irrigation Engineer, Soil Conservation Service,
Department of Agriculture

One of the big opportunities for water savings is in irrigation agriculture, where a large part of the supply in arid areas is now used. In some Western watersheds as much as 90 percent of the streamflow is devoted to irrigation, and in the East irrigation is rapidly becoming an accepted practice.

The U.S. Geological Survey estimated that, in 1955, 123 million acre-feet of water were used for 34 million acres of irrigated land in the United States. Of this amount 91 million acre-feet were delivered to farms and 32 million acre-feet, or approximately one-fourth, was lost in conveyance.

There have been estimates that by 1980 it should be feasible to effect a savings of 1 million acre-feet by evaporation control and 2 million acre-feet by controlling phreatophytes. Other savings can be achieved with an aggressive canal lining program.

But what of the 91 million acre-feet delivered to the farmers' headgates? What is the water-use efficiency measured in terms of the percentage of the water delivered to the root zone of the crop? In other words, how much of the water is actually made available for crop production?

If water is put on the field too rapidly for the soil to absorb it, some runs off. If more is applied than the soil can hold in the root zone, the excess soaks to a depth where it is unavailable to the crop. In either case water is "wasted."

In 1944 Dr. O. W. Israelsen, Utah State University, Logan, and W. D. Criddle, State engineer, Salt Lake City, found that farm irrigation efficiencies in two counties in Utah ranged from 18 to 58 percent, with averages of 35 percent and 40 percent. In 1952, the Bureau of Reclamation reported farm efficiencies ranging from 34 to 70 percent on 13 Federal irrigation projects.

The Department of Agriculture, in its report to the Senate Select Committee on Water Resources, estimated the average farm application

Note: Condensed from paper presented at National Water Research Symposium, Washington, D.C., March 28–30, 1961.

efficiency on the irrigated land of the United States is about 47 percent. This would mean that out of the 91 million acre-feet delivered to farms in 1955, over 48 million acre-feet were handled without benefit. Such costly over-application of water waterlogs productive land, accelerates the accumulation of alkali and other salts, erodes fertile topsoil, and leaches plant food out of the root zone.

Is the excess water wasted? Can seepage water that returns to the streams or underground aquifers be used again? In many of our western river basins this is quite feasible and is now being done. The Department of Agriculture has estimated that an average of 55 percent of the on-farm distribution losses could be recovered and reused further downstream. But each time irrigation water is used its quality is impaired.

The fact that wasted water can often be reused downstream is no justification for "inefficient" irrigation methods.

USGS figures for water use in 1955 and the Department of Agriculture's estimate for recovery of farm distribution losses indicates that about 22 million acre-feet of water each year are being wasted. These farm losses added to the non-recoverable losses from canals and reservoirs total nearly 40 million acre-feet of good quality water that are being "run down the drain."

This would be enough water to supply 1 acre-foot to each acre of irrigated land that will be needed in the Western United States in the year 2000.

The Department of Agriculture, in its report to the Senate Select Committee on Water Resources indicated that with a 15 percentage point increase (from 47 to 62 percent) in our average water use efficiency on irrigated farms, coupled with a 10 percentage point increase in the efficiency of storage and delivery systems, enough irrigation water could be saved to take care of the predicted 88 percent increase in irrigated acreage in the year 2000 with only a 20 percent increase in water supplies.

It should be kept in mind that these figures are based on national averages, and a national balance of supply and demand will not reveal the water problem of any given locality. No community experiences national averages; each must contend with its own peculiar water-resource balance and its relation to the available irrigable land. Location and distribution of water are usually as important as the overall supply.

In the West, where from the beginning water

Good irrigators know their soil and test its moisture content and water holding capacity, applying only enough to fill the root zone.

supplies have been limited, continued growth depends on finding ways to make the present supply go farther.

Irrigation practices that cause low efficiencies are not always necessary. Modern and progressive farmers have the equipment and the know-how to get precise distribution and control of their water. Conservation farmers using irrigation systems designed to fit their individual conditions of soil, climate, water supply, crop requirements, and farming operations attain high degree of efficiency in water use. Cooperators with soil conservation districts following competent technical guidance, commonly attain application efficiencies above 70 percent.

Twelve farmers in the Lower Yellowstone Irrigation project in North Dakota reported a saving of at least 300 acre-feet of water on 307 acres of beets and beans in one growing season as a result of land leveling and improved irrigation practices. They reduced the average amount of water applied per irrigation from 9 to 4 inches and the labor requirements from 8 to 2 hours per acre. On alfalfa and small grain fields the improved irrigation systems reduced average water application from 8 inches to 4 inches and labor requirements from 3 hours to one-half hour per acre per irrigation.

The Redlands-Highland Soil Conservation District in California arranged with the Soil Conservation Service for the services of an irrigation engineer and a conservationist to help cooperators revise their irrigation systems and show how and when to apply irrigation water. As a result of changes made in the 10-year period 1950–59, the farmers used 50,220 acre-feet less water than they would have used under previous methods and saved $1 million in water and labor costs.

In 1960 they saved 12,880 acre-feet of water which would have cost an average of $17 per acre-foot. This indicates a saving of $219,000 in 1 year. But more important is the fact that pumping from the supply was reduced and a more dependable supply of water during the dry season was assured. Yield, size, and quality of fruit were as good or better after the reduction in water use and there was less root rot and less leaching of fertilizer from the soil. These improvements not only benefit communities and the Nation, but also the individual farmer. # # #

A good land-leveling job with the proper relation between stream size, soil type, and border area saves both water and soil.

Uncontrolled irrigation water erodes land and wastes water. (*Photos by Soil Conservation Service, Agriculture Department.*)

AROUND THE CORNER

more water for the intermountain west

A bright future lies just around the corner for irrigation farmers in the intermountain West. And once that corner is turned in 1962, new projects will be completed and bring more water to more farmers as the years roll by. All this is possible because of the program authorized in 1956 for development of the waters of the Upper Colorado River and its tributaries, a project that reaches into Arizona, New Mexico, Utah, Colorado, and Wyoming.

Eleven Federal Reclamation projects—called *participating projects*—were authorized by the Congress in 1956 as part of the vast billion-dollar Colorado River Storage project. Three of these eleven projects will store and deliver water to farmers in 1962, and construction is underway on three others. Preconstruction (advance) planning investigations are now in various stages of completion for three other projects authorized in 1956.

Legislation has been introduced in the Congress for authorization of three additional participating projects, and feasibility reports are near completion for another three projects. (Summary information on these 15 projects is given at the end of this article.) And, finally, planning studies are being pushed ahead on still other proposed projects.

The great storage-unit dams of the Colorado River Storage project, such as Glen Canyon in Arizona, have captured the attention of the general public in the years since the 1956 authorization of the Upper Basin program. They have been called the keys to the program, and they are, with their ability to regulate the flows of the Colorado River and its main tributaries and to produce power revenues to finance a major part of the vast undertaking.

But not to be overlooked is the fact that the *direct water-use benefits* to result from the Upper Basin program will take place on the participating projects where water will be put to beneficial, consumptive uses on a large scale. Of major significance to the people of the Upper Basin States are the long-recognized direct benefits from expanded irrigation agriculture and from the supplies of water for municipal and industrial use that the participating projects will make possible.

The presently authorized projects will provide full water supplies for 114,000 acres of new land,

by PAUL T. SANT, Chief, Economic Resources Branch,
Project Development Division
Salt Lake City, Utah

and supplemental water for 232,000 acres of presently irrigated land which is short of water nearly every year. The six projects for which feasibility reports are completed or nearly completed will serve an additional 400,000 acres of new and supplemental lands.

The other projects now under active investigation, or earmarked for early study, could add another 300,000 acres of land in participating projects. Thus, a total of more than 1,000,000 acres will be included in Upper Basin participating projects in future years. The sum of the direct benefits to be gained over the years as these participating projects come into being heralds a bright future.

In nearly all cases, these projects have not been built in the past because the direct beneficiaries—the irrigation farmers—could not repay in full the reimbursable costs of those projects in 40 years as required under Federal Reclamation law. Now, however, under the basinwide program, net power revenues from the storage unit powerplants will be utilized to assist in and to assure full repayment of reimbursable costs. Also, the river regulation provided by the huge storage unit reservoirs will assure conformance to the 1922 Colorado River Compact and thereby will make possible the increased consumptive water use on the more than 1,000,000 acres to be benefitted by the Upper Basin participating projects.

The direct and indirect benefits from the expanded irrigation farm business looming for the Upper Basin States through the participating

Paonia Dam in Colorado will assure adequate water (full or supple

Participating projects of Colorado River storage project will increase livestock, such as these sheep grazing on irrigated pasture.

projects more than justify the reimbursable expenditures involved—expenditures that will be repaid in full in 40 years.

What are the direct benefits? Where dry grazing lands are converted into new irrigated farms, the farm employment and the value of crops grown will far exceed the present return from those lands. Where supplemental water is provided to existing irrigated land that is chronically short of adequate water supplies, either more intensive crops can be grown, or notably higher yields can be obtained from the same crops as are now grown. In both cases, expanded farm business results.

With supplemental water assuring an adequate

o total of 15,300 acres. This is downstream embankment of dam.

yearly supply, much Upper Basin irrigated land now growing forage and feed crops could produce the more valuable fruit and truck crops, or such crops as potatoes, sugar beets, and canning crops. However, the lands which are not adaptable for these higher value crops would produce significantly greater yields of the present crops. For example, some lands now yielding 1½ to 2 tons of hay or 30 to 35 bushels of barley could yield, with adequate irrigation water supplies, 3½ to 5 tons of hay or 60 to 70 bushels of barley per acre.

Ready markets are assured for the expanded irrigated farm production to result from the participating projects. The population of the Upper Basin States has been growing by leaps and bounds, particularly in the larger city areas where the impact of industrial growth has been a major factor. The population of the four Upper Basin States—Colorado, New Mexico, Utah, and Wyoming—has increased 60 percent in the past 20 years. This is a growth rate faster than prevailed for the Nation as a whole. The 3,926,000 four-State population of 1960 is expected to exceed 5,000,000 by 1975. Obviously, the local markets for farm products from the participating projects will be growing markets.

In addition, the heavy and continuing population growth in the Pacific Coast States, particularly in California, also offers growing markets for participating project farm products. It is a well established, but too often little understood fact, that irrigation projects producing the type of crops to be grown on the participating projects of the Upper Basin do not contribute to the Nation's supply of crops in surplus.

The expansion of irrigation agriculture through the construction of the participating projects will establish oases throughout the arid Upper Colorado River Basin. Communities will grow, and this stable aspect of the overall economy of the region will be greatly expanded.

Along with the expansion of irrigation farming will come, as it already has to some degree, the development of industries utilizing the vast mineral resources of the Upper Colorado River Basin. Oil and gas discoveries since World War II have been extensive and exploration continues on a large scale. Last year, mining of phosphate ores

Stockman on Florida project looks forward to more adequate water supply, better feed base for his white-face Hereford beef cattle.

Wasatch Range towers above Springville, Utah, in Central Utah project area, provides water source in form of snow.

began in the huge deposits on the south flank of the Uinta Mountains near Vernal, Utah.

A new plant is under construction near Green River, Wyo., to mine trona, a mineral which is processed into soda ash, a chemical in great demand for many uses. Near Moab, Utah, huge potash deposits will be mined and processed at a plant now under construction. Large steam electric generating plants, utilizing tons of the great deposits of coal in the Upper Basin, are being planned or are under construction near Kemmerer, Wyo.; Craig, Colo.; and Shiprock, N. Mex.

Another facet of the diversifying Upper Basin economy will be the recreational development. Much of the Upper Basin is fascinating, colorful, largely unopened wild country. For example, Lake Powell, the reservoir to be formed behind Glen Canyon Dam, will back a 186-mile-long lake into the unparalleled canyon country of southeastern Utah. Several new National Parks have been proposed in the Upper Basin by Secretary of the Interior Udall. Tourism will become a major "industry" in the Upper Colorado Basin.

Following are some details of participating project progress.

Water in 1962

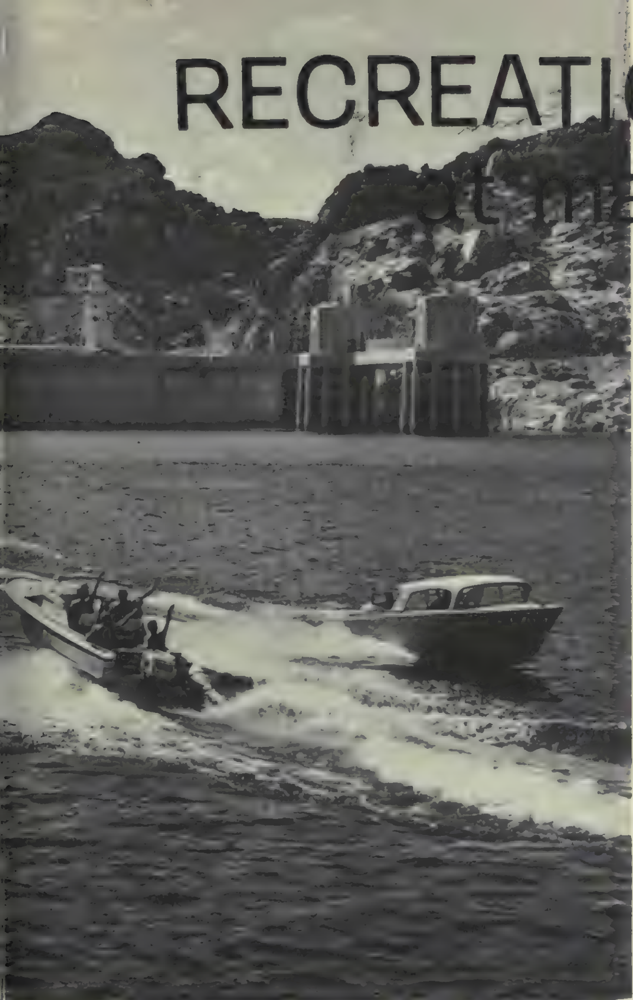
Hammond Project, New Mexico. A 3,900-acre project in a sunbaked desert area near Bloomfield, N. Mex., the Hammond project area was first settled in 1870; but all that was left were the abandoned ditches which offered stark testimony of the unsuccessful attempts to build and maintain permanent diversion dams on the San Juan River. The new diversion dam, distribution canal, pumping plant, and laterals will provide full supply of water to these dry acres.

Paonia Project, Colorado. Construction of Paonia Dam on Muddy Creek and the lining and extension of the Fire Mountain Canal will assure adequate water for 13,100 acres of supplemental land and 2,200 acres of new land. The Paonia area is noted for fruit production—peaches, cherries, and apples—as well as livestock, feed, and forage.

Vernal Unit, Central Utah Project, Utah. Chronic water shortage will be eliminated on the

(Continued on page 111)

RECREATION at man-made lakes



Part III

Lakes in the sun—summer or winter—include several Bureau of Reclamation reservoirs which have long been favorites with the surrouding residents and with vacationers and sportsmen from across the Nation.

Such reservoirs—Elephant Butte in New Mexico and Lake Mead between Arizona and Nevada, for instance—are set in the midst of attractive and varied natural scenery where outdoor activity takes precedence throughout much of the year.

These reservoirs—across the Southwest and near the Pacific coast—were built to provide irrigation for farming, water for homes and industry, electric power, and river control, and at the same time serve the growing recreation requirements of the Nation.

Elephant Butte

Elephant Butte and Caballo Lakes are located on the Rio Grande just outside the city of Truth or Consequences, N. Mex., which bills itself as a recreational paradise.

With pardonable pride in their Reclamation lake, the local people write of Elephant Butte Lake, thusly: "Like a silent, giant, Elephant Butte (landmark in the lake) can be seen for miles in each direction, as it stands sentinel over millions of acre-feet of blue, sparkling water, stored up to provide recreation for visitors and irrigation for thousands of acres of some of the country's richest agricultural lands.

"A fisherman's paradise! With giant bass, catfish and crappie yours for the taking any season of the year . . . In addition, the Rio Grande, which flows out from Elephant Butte Dam, is kept stocked in the cooler seasons with trout . . . Boating and water skiing on the sparkling blue lake is a year-round sport. Speedboat races are a holiday feature on the placid waters of Elephant Butte Lake.

"Like a mirage, the shimmering waters of Ele-

phant Butte Lake surprise the visitor who has driven through hundreds of miles of semiarid country."

The lake covers 36,600 acres and has a shoreline of 200 miles.

The surrounding country provides many trails for those who wish to employ their own initiative and ingenuity, and the town offers the hospitality of the Old West.

To the west of Elephant Butte Lake is the Black Range where wild game—turkeys, deer, antelope, and pheasants—find shelter, as well as lions, cougars, bear, fox, and coyotes.

Southward, the visitor can drive to historic forts and landmarks of the early exploration of the area.

In Truth or Consequences itself are facilities for outdoor activities ranging from swimming and golf to horseshoe pitching and trap shooting. Each spring the town puts on a Fiesta which had its inception in 1950 and now ranks among the biggest shows in the "Land of Enchantment."

Lower Colorado Reservoirs

Reclamation's stairway of dams on the Lower Colorado River not only has tamed the river and provided water and electric power to make the desert habitable, but has created sparkling sky-blue reservoirs to turn the area into another vacationland.

Lake Mead behind Hoover Dam is one of the most visited recreation areas in the country. Other downstream dams—Davis, Parker, Headgate Rock, Palo Verde, and Imperial—have also added to the vast recreation and fish and wildlife treasures resulting from Reclamation's multipurpose development.

And looking to the future, Glen Canyon Dam, 370 miles upstream from Hoover Dam, late in 1962 will begin storing water in its reservoir—Lake Powell—to add a new step in the stairway of dams and thus multiply the Colorado River's recreation and fish and wildlife benefits.

Last month, the Bureau of Reclamation and the National Park Service—Department of the In-

West of Elephant Butte Lake in New Mexico, during November, deer hunters use horses to carry camping equipment.

terior agencies—joined in commemorating the 25th anniversary of the Lake Mead National Recreational Area. Surrounding this hemisphere's highest dam and largest manmade reservoir—Hoover Dam and Lake Mead—the area has been visited by more than 40 million people since its establishment in October 1936.

During all seasons of the year, sportsmen flock to Lake Mead as well as to other downstream reservoirs and river stretches to fish, boat, swim, water ski, skin dive, camp, picnic, explore, take pictures, study nature, and "just plain relax."

The Lake Mead National Recreation Area, set in the midst of rugged and picturesque southwestern desert country, contains 3,000 square miles of land and water in Nevada and Arizona. It extends 240 miles from Grand Canyon National Monument, on the east, to the Colorado River below Davis Dam on the south. Some 93 miles of the Grand Canyon of the Colorado River lie within the area.

The area has much recreation and many scenic wonders to attract visitors. Besides the daily tours of Hoover and Davis Dams, visitors find excellent facilities provided by the National Park Service and its concessioners at various points around Lakes Mead and Mohave.

The National Park Service offers free facilities which include picnic areas, boat docks, launching ramps, information and ranger stations, evening naturalist programs, campgrounds with modern comfort stations, tables, fireplaces, waste receptacles, and water hydrants. Swimming beaches with lifeguards on duty during summer are maintained at Las Vegas Bay and Boulder Beach on Lake Mead and at Katherine Wash on Lake Mohave.

National Park Service concessions operated by private enterprise provide lodging, meals, trailer spaces, stores, and other facilities, including boat servicing and rentals.

The Lake Mead hydroplane and other boat races, ski races, the Needles Boat Marathon, the Blythe Boat Cruise and other competitive and noncompetitive sporting events churn the waters of the Colorado River and its reservoirs throughout the year.

The Gold Cup races were held on Lake Mead in 1960. This world series of unlimited hydroplane racing attracted thousands of spectators from around the globe.

In addition to its own attractions, the Lake Mead National Recreation Area is surrounded by tourist meccas like Grand Canyon, Bryce, Zion, Lehman's Cave, Death Valley National Monument, Valley of Fire State Park, Mount Charleston, Eldorado Valley, and scores of old mining and ghost towns. These are within easy reach and short driving distances.

One of America's leading resort cities—Las Vegas, Nev.—is a 30-minute automobile drive from Lake Mead National Recreation Area over U.S. Highways 93, 95, and 466. Like Los Angeles and many other cities of the Pacific Southwest, Las Vegas is nourished with water and power from Hoover Dam.

West of Caballo reservoir, New Mexico, road climbs 8,000 feet above sea level; picnic areas are plentiful beneath the pines.

Las Vegas sponsors one of the West's most colorful events — Helldorado — every spring. Residents dress in western clothing—men grow beards or else are fined and jailed in an open-air "pokey" on Fremont Street, the main downtown avenue. Rodeos, parades, and other frolics turn the event into a desert "Mardigras."

West of Las Vegas Valley and only about 90 minutes by automobile from Hoover Dam, northwest over U.S. Highway 95 and State Highway 52, are the Mount Charleston peaks—snowcapped in the winter. There, sport enthusiasts find complete facilities for skiing, skating, and camping. The mountains provide a cool haven for picnickers and campers during the summer. Charleston Park lies within the Toiyabe National Forest, a 61,567-acre island of high mountainous forest surrounded by a "sea" of desert.

The Valley of Fire State Park lies in southern

Nevada only a few miles from the Overton arm of Lake Mead. From Hoover Dam it is only about a 90-minute automobile drive via U.S. Highway 93 and over a turnoff on State Highway 140. The Valley of Fire is a 30,000-acre expanse of brilliant red sandstone. It changes in form and hue with each hour of sunlight.

At nearby Overton, visitors find the Lost City Museum, a renowned institution which displays and interprets the ancient cultures which abounded in the Valley of Fire-Lake Mead region.

Death Valley Monument, in southwestern Nevada and east-central California, is a 4-hour drive from Hoover Dam over U.S. Highway 95 and then on State highway turnoffs. Running in a generally northwesterly direction, the monument, established in 1933, covers nearly 3,000 square miles. At one point it is 282 feet below sea level—the lowest land in the Western Hemisphere.

Fishing is a major attraction of Lake Berryessa, a part of multipurpose Solano Reclamation project in San Francisco Bay area.

Visitors driving from Hoover Dam to Lehman Caves National Monument, directly north in Nevada on U.S. Highway 93 and State highway turnoffs, should allow themselves about 6 hours travel time. The monument is a vast, intricate, and beautiful cavern system underlying the flank of 13,061-foot Wheeler Peak.

In southwestern Utah—about a 5-hour drive from Lake Mead National Recreation Area—is the inspiring and majestic Zion Canyon, reached on U.S. Highway 91 and turnoffs on State Highways 17 and 15. Covering 143,294 acres, Zion National Park is a scenic paradise of colorful, deep, narrow canyons, sheer rock walls, and impressive individual rock masses.

Another 2-hour drive in Utah from Zion along State Highway 15, U.S. Highway 89, and State Highway 12 takes visitors to Bryce Canyon National Park. A narrow strip of land called the Pink Cliffs stretches 25 miles to mark its location. Within its 56 square miles, and below the sheltering walls of a natural amphitheater stand miniature cities, cathedrals, and temples shaped by ceaseless work of rain and snow and sun and ice on limestone varying in resistance.

Grand Canyon National Park is perhaps the greatest and most popular of the parks within a day's drive of Hoover Dam and Lake Mead. Visitors reach this mile-deep canyon of contrasting colors and formations via highways from the north, east, and south. The trip from Hoover Dam to the south rim of Grand Canyon over U.S. Highway 93, U.S. Highway 66, and State Highway 64 takes about 6 hours.

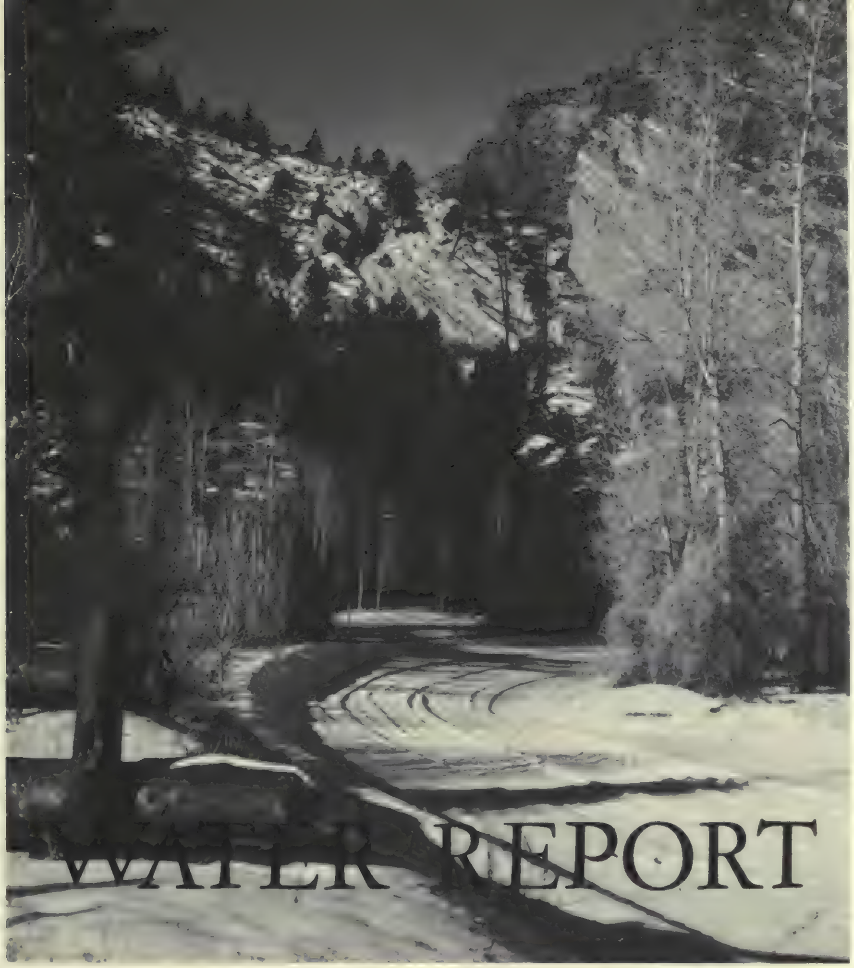
California Reservoirs

Reclamation reservoirs that are especially inviting in spring dot the California landscape almost the full length of the State. Going generally from south to north, the traveler will find Lake Cachuma near Santa Barbara, newly completed Lake Casitas in neighboring Ventura County, Lake Woollomes (Delano Equalizing Reservoir) near Delano, Millerton Lake near Clovis, Jenkinson Lake near Placerville, Folsom Lake (Corps of Engineers reservoir) near Folsom, Lake Berryessa near Winters, East Park and Stony Gorge reservoirs near Willows, Shasta Lake near Redding, and the new Trinity Reservoir near Lewiston. A few details on some of these lakes follow.

Lake Cachuma on the Santa Ynez River is a source of domestic water for Santa Barbara and the surrounding area and therefore, to guard against pollution, all water-contact sports such as swimming, water skiing, and skindiving are prohibited. But there is good fishing and boating on the 3,090-acre water surface, and excellent campgrounds are nearby.

Lake Casitas, situated in Santa Barbara's neighboring county of Ventura near the town of Oak View, was completed only recently, but once filled to capacity it will have fishery and other attractions to rival Cachuma. The new lake is

(Continued on page 109)



WATER REPORT

As was indicated by the mountain snowpack during the 1960–61 winter season streamflow proved deficient over a wide area of Western States this past summer season. Reduced streamflow, coupled with limited carryover storage in irrigation reservoirs resulted in severe shortages of surface water for irrigation in the states of Utah and Nevada, the large Central Valley of California, and adjacent areas of Oregon, Idaho, and Wyoming. Irrigated lands along the Snake River and its major tributaries in Idaho had near normal water supplies, but at the expense of exhausting storage in large reservoirs in most areas. The use of groundwater as a supplemental supply was extensive.

The 1961 drouth was the third in succession for these areas of the West. Planning done by all water users during the spring months helped to bring water demands in line with the prospective supplies. Reductions in crop acreage, development of groundwater, and planned utilization of available water supply did much to reduce economic losses.

Streamflow along the Rio Grande was again deficient. Groundwater supplies provided a major part of the total water supply. Streamflow in Arizona was only about 40 percent of normal, but stored water in the Salt River reservoirs provided a normal water supply. The San Carlos project depended almost exclusively on pumps. The Central Valley of California had the third successive year of drouth. Even with groundwater and storage and intensive conservation measures water shortage was relatively severe in parts of the San Joaquin Valley.

The flow of the Colorado River and its tributaries into Lake Mead was less than one-half normal. Some late season shortages occurred on most upper basin tributaries where storage is not available. Rainfall during early summer was extremely deficient.

Streamflow in the Columbia River system was near normal except for the Snake River and its tributaries in southern Idaho and eastern Oregon. Extreme shortages of irrigation water was experienced on some of the smaller tributaries in Idaho and Oregon along with adjacent areas in central Oregon. Seasonal flow was characterized by high flows during the peak of snowmelt in late May and early June and much below average flows during the July–September period. Limited late season shortages occurred along some small tributaries depending on direct diversions.

Streamflow in the Upper Missouri River Basin was 60 to 80 percent of average. Water supplies were generally adequate but carryover storage is low. Streamflow from low elevations and prairie streams was extremely deficient.

Not all areas had such extreme shortages. The central Great Plains had well above normal rainfall extending westward to the Continental Divide in Colorado. This

by Homer J. Stockwell, Staff Assistant, Water Supply Forecast Unit, Soil Conservation Service, Portland, Oregon

summer rainfall reduced water demands to a minimum in most areas. Streamflow near normal provided adequate water supplies and allowed generally for an increase in carryover storage. Streamflow on the North Platte in Wyoming was about two-thirds of average. Carryover storage is also less than average.

Looking forward to the 1962 season, there is little as yet to indicate the drought conditions over the Great Basin and adjacent areas in Idaho and Oregon, along with the Central Valley of California will be materially improved over 1961. Most critical is the extreme lack of reservoir storage. Storage has been reduced to less than 20 percent of capacity and to about 40 percent of normal for October 1 in some 200 representative irrigation reservoirs in western states. Storage in the most critical areas is practically exhausted.

During September there have been reports of heavy rainfall in mountain areas here and there. This will improve mountain soil moisture on these watersheds. However, a much above average snowpack for the entire 1961–62 season is needed. In order to restore a safe margin for the drought areas, it will be necessary not only to have enough winter snowpack to provide average streamflow in 1962, but enough excess streamflow to bring irrigation reservoirs to near average operating levels.

Water users will find it advantageous to keep informed as to the mountain snow accumulation during the winter and spring months of the 1962 season. It is possible that adjustments in demands might again have to be made to a short water supply. Should the winter snowpack be deficient, the outlook for water shortage will be even more severe and extensive than in 1961.

This report for RECLAMATION ERA is based on information gathered from officials of Federal and State agencies and water using organizations by snow survey supervisors of the Soil Conservation Service.* It is prepared under the direction of R. A. Work, Head, Water Supply Forecast Unit of the Soil Conservation Service.

In the following paragraphs, water conditions by States are briefly reviewed, emphasizing conditions that affect the 1962 water supply outlook.

ARIZONA—Although spring runoff was only 40 percent of average, water supplies were not deficient in most of Arizona. Pumping started early in the Upper Gila Valley, but summer storms reduced pumping requirements. The San Carlos Project, however, has had to pump extensively this year. Summer precipitation has been near normal in most of Arizona producing fair runoff. Reservoir storage in central Arizona last January was 150 percent of average. It is still 120 percent of average. Thus, an average winter snowpack should produce a better than average water supply for 1962. Range feed conditions are fair in most places. Stock water is adequate in all but two northwestern counties.

CALIFORNIA—California Department of Water Resources, coordinating agency for the California cooperative snow survey program, reports that precipitation and snowpack approached drought proportions in all but the northern portion of the State this past season. Streamflow and reservoir storage were, of course also seriously deficient—for the third consecutive year. This third consecutive year of short supplies, with the possibility of one or more dry years to follow, prompted the Governor and Director of Water Resources to call statewide conferences in Sacramento and Los Angeles to help alleviate current and future shortages.

Even with diligent application of conservation measures, serious shortages for agriculture and municipal supplies occurred in many areas. The San Joaquin Valley was particularly deficient in water for agricultural uses. Agricultural users in much of this area again survived by pumping groundwater to supplement deficient surface supplies.

The dry year naturally increased forest fire hazards and many thousands of acres have been burned over already with the end of the fire season still weeks away at the time this is written. California fish and game, too, have suffered from the effects of the dry year. Now, at the end of the irrigation season, carryover storage in most California reservoirs is extremely low. All of California hopes for heavy winter precipitation during the season ahead.

COLORADO—Water supplies east of the Continental Divide, except for the Rio Grande, were more than adequate during the 1961 season. Rainfall during the summer months increased the flow from snowmelt to slightly more than anticipated. The rainfall also reduced demands during the runoff season and allowed for an increase in reservoir storage. The South Platte experienced one of its better water supply years. Water supplies along the Arkansas River were also adequate. A few shortages were noted west of the Continental Divide and along the Rio Grande and its tributaries. These shortages occurred mostly along the small tributaries of the Colorado. Water supplies along the major streams were adequate throughout the season. Pumping was again used extensively on the Rio Grande in the San Luis Valley to supplement surface supplies.

Early season snow storms in late August and September have already accumulated some snowpack on Colorado mountain watersheds. Except for the Rio Grande, the outlook for next year is relatively good at this time.

IDAHO—Streamflow was near average in northern Idaho and somewhat less than average in the Clearwater and Salmon Rivers. The snowmelt runoff peak on the Kootenai watershed was higher than anticipated from last winter's snowpack. Almost record high stages occurred in late May and early June.

For the main irrigated area of the State on the Snake River and its tributaries, water shortages caused crop acreage reductions, particularly along the small southern tributaries. Forecasts last winter and spring of impending shortages resulted in all concerned planning to conserve available water supplies. The use of groundwater was extremely heavy on the Minidoka North Side project. There was some restriction in deliveries in late August and September along most irrigation systems along the Snake, except for the Payette River.

Reservoir storage is generally down to 10 to 20 percent of the average carryover and much below that of a year ago. The 1962 seasonal supply will be almost entirely dependent on the seasonal runoff, which is not the usual situation along this relatively large stream. If snowfall during the 1961–62 season is deficient, water shortages will be more severe than were experienced in 1961.

MONTANA—Streamflow from April through September was below average in Montana with the exception of the Flathead and Kootenai drainages which were near average. Runoff in the Upper Clark Fork and Bitterroot drainages was 60 to 70 percent average. East of the Divide, streams originating at higher elevations produced 60 to 80 percent average flow. Low elevation and prairie streams flowed only 20 to 40 percent average for the summer months.

There was some shortage of irrigation water this year,

(*Continued on page 110*)

***The Soil Conservation Service coordinates snow surveys during the winter and spring months conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal agencies, various departments of the several States, irrigation districts, power companies, and others. The California Department of Water Resources, which conducts snow surveys in that State, contributed information on California water supply as a part of this report. The Water Rights Branch, British Columbia, Department of Lands and Forests has charge of the snow surveys in that province.**

FAREWELL TO "MR. RECLAMATION"

GOODRICH W. LINEWEAVER

by MICHAEL W. STRAUS
Former Reclamation Commissioner (1945–53)

Goodrich W. Lineweaver completed a unique Government career that more nearly qualified him for the title of "Mr. Reclamation" than any contemporary when death came to him on the evening of August 8, 1961, in Washington, D.C., as he approached his 75th year.

For over a third of a century he served with distinction and success under five Secretaries of the Interior, four Commissioners of Reclamation, and many Congresses of the United States.

He was always a proclaimed realist and his constant objective was to advance the reclamation program in which he was an unwavering believer and to which he was a major contibutor. This was his principal, and in later years, his consuming and virtually sole activity.

No westerner, but a reclamationist by his own choice, Goodrich Lineweaver was born in Harrisonburg, Va., where, as he frequently observed, he "grew up in the fried chicken and hot bread country where I was voting before I learned that 'damyankee' was really two words."

He worked on newspapers in Virginia and West Virginia and served as an Army lieutenant before entering the field of Federal water and power development. His debut was as Secretary of the old Federal Power Commission in 1934. From there he moved into the National Reclamation Association, the Department of the Interior, the Bureau of Reclamation, and finally the staff of a committee of the U.S. Senate.

Possessed of a persistent personality, he accepted the 17 Western Reclamation States as his beat and Washington as the center of his operations. He accumulated a vast lore of Reclamation which fascinated him to the exclusion of other endeavors.

He labored with many western groups intimately to get general but ill-defined water proposals into presentable and feasible shape. He became a master of the controversy and compromise frequently required in launching a new Reclamation endeavor. Many such works today, in a minor or major measure, stand as monuments to his ceaseless efforts.

During the decades of this free-wheeling activity, at various times, he bore titles in the Bureau of Reclamation of Director of Information, Secretary of the National Reclamation Repayment Commission, Chief of Research, leader of the Columbia Basin Joint Investigations, Director of Operation and Maintenance, Assistant to the Commissioner for Regionalization, and, under my commissionership, Assistant Commissioner.

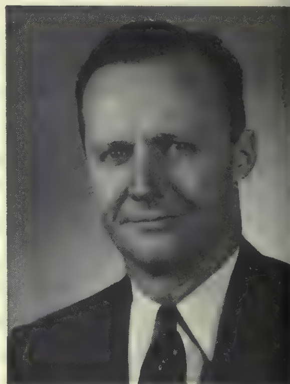
In 1955 he joined the staff of the Senate Interior and Insular Affairs Committee. Far past retirement age, he remained active until ill health and exhaustion forced his retirement and hospitalization last spring. His wife, the former Evelyn Koogler, died in March, followed in August by "Mr. Reclamation" himself.

Last services, held in Washington, were attended by many representatives of the Reclamation world and the Government. # # #

MEET THE NEW DIVISION CHIEFS

JOHN W. MUELLER

D. REGINALD HICKS



L. RAY AWTREY

The reorganization of the Bureau of Reclamation's Washington Division of Organization and Personnel into two separate divisions and the filling of the top position in the Division of Power furnish the opportunity to introduce three key Bureau men to ERA readers.

John W. Mueller, as announced in the August issue, is the new power chief, coming to the Bureau from the Niagara Power project at Niagara Falls, N.Y. He was formerly with the Bureau's Region 2 office in Sacramento, 1946–54.

D. Reginald Hicks, a Bureau employee since 1944, and Assistant Chief of the former Division of Organization and Personnel, is now Chief of the Division of Personnel. L. Ray Awtrey, who has been with the Bureau since 1946, is Chief of the Division of Organization. He was Chief of the Organization Branch in the old division.

Mr. Hicks is a native of Imperial, Nebr., and has bachelor's and master's degrees from Colorado State College at Greeley. Mr. Awtrey, from Athens, Tex., has bachelor's and master's degrees from the University of Oklahoma and an L.L.B. from George Washington Law School. # # #

90TH BIRTHDAY

G. O. Sanford of Marshfield, Mass., pioneer reclamationist, observed his 90th birthday on August 17.

Mr. Sanford began his long and productive career in reclamation in 1905 as Assistant Engineer of the Bureau of Reclamation's Buford-Trenton project in North Dakota. As he assumed more and broader responsibilities, he was, in succession, in charge of the Milk River, Shoshone, and Sun River projects and served in the Washington office where in 1935 he was appointed General Supervisor of Operation and Maintenance.

Mr. Sanford is the father of Hollis Sanford, Chief of the Bureau's Division of Irrigation Operations in Denver. # # #

PIONEER DIES

R. H. McElhaney, a pioneer reclamationist and settler in the Gila Project area, Arizona, died September 5. Mr. McElhaney, whose home was at Wellton, Ariz., and his wife became homesteaders in 1924. He took an active part in reclamation matters and was first president of the Wellton-Mohawk Irrigation and Drainage District.

CORRECTION

In the August 1961 ERA, the article entitled "Crop Report" on page 64 should have stated that more than 8 million persons live in communities where the domestic and industrial water supplies were augmented in 1960 from Reclamation sources. Through a typographical error, the number was reduced to "a million."

Recreation at Man-Made Lakes
(Continued from page 104)

a source of domestic as well as agricultural water supply, and water-contact sports are prohibited.

Millerton Lake is formed by Friant Dam on the San Joaquin River, which flows crystal clear from snows of the high Sierras. Situated where the foothills meet the valley, the lake, which provides lifegiving water for valley agriculture, attracts boaters, picnickers, and fishermen. During the summer, in early evening when the sun no longer blisters, residents of the valley don bathing suits and converge on the lake for relief from the heat. Often metropolitan visitors include the lake in their itineraries along with fairs and harvest festivals at Bakersfield, Tulare, Fresno, and other San Joaquin Valley towns.

Jenkinson Lake, a mile-square blue jewel set amid Sierra evergreens, comes to life in the spring with the opening of the trout season. Later, with the arrival of summer weather, the trout are less eager and water skiing predominates. El Dorado County, serving as host to approximately 50,000 annual visitors, has provided campsites, picnic tables, toilets, and oiled roads.

Folsom Dam impounds the American River just below the confluence of the North and South Forks to form an 11,500-acre lake. Recognizing its recreational value, the State of California has included the entire lake and its 76 miles of shorelands in the State park system along with Lake Natoma below it—a small reregulating pool some 5 miles long. Swimming, sailing, water skiing, angling, picnicking, and sightseeing are included in the 2 million visitor-days of use annually.

At nearby Coloma, the 1849 gold discovery site is now commemorated as John Marshall Historical Park. A new museum houses the relics of Marshall's historic discovery that started the gold rush.

Lake Berryessa is within 2 hours of 2 million people in the San Francisco Bay area and nearly a million more have access from surrouding towns. Camp and picnic grounds, boats, launching ramps, bait and tackle shops, refreshment stands, and trailer parks are provided by concessioners. Use of the 20,700-acre lake is supervised by Napa County under an agreement with the Bureau of Reclamation.

Shasta Lake is formed by multiple-purpose Shasta Dam which closes a gap in the mountains of northern California to flood the canyons of the Sacramento, McCloud, and Pit Rivers and Squaw Creek. Fingering into these canyons the shoreline of the lake meanders some 365 miles in and out of innumerable coves and bays. Twenty resorts, a dozen picnic grounds, 300 campsites, and 160 summer homes lie secluded along their shores.

# # #

(This concludes a three-part series.)

Bryce Canyon National Park, Utah, is day's drive of Hoover and Glen Canyon Dams. ***(National Park Service photo.)***

Water Report

(*Continued from page 160*)

but generally the water supply from reservoirs and streams was sufficient to mature crops.

Precipitation during the summer months was below normal with drought conditions prevalent in the eastern portion of the State. Generous rains in September brought some relief to the drought areas and soil moisture conditions over most of the State are improved.

Storage in irrigation reservoirs is low with many reporting no storage. If streamflow next year is deficient, a critical water supply could result in some areas.

NEVADA—Irrigation season streamflow in Nevada during 1961 ranks among the lowest in the water history of the State. April–July streamflow ranged from 15 percent to 50 percent of average. Principal irrigation reservoirs which stored water to 21 percent of capacity at the beginning of the crop growing season now stand at only 5 percent of capacity.

In spite of the limited irrigation water supply available this year, Nevada ranchers and farmers have obtained good yields on the reduced acreages. This can be attributed to their careful water management, reduction in crop acreages, with only the best lands being irrigated, good spring rainfall, and summer thunder showers, and supplementary water in some areas from groundwater.

Water users, whether served from reservoirs or by direct diversion, will be almost totally dependent (except for groundwater supplies) on snowfall in the mountains next winter to provide next spring's and summer's irrigation water supplies. Should the mountain snowpack prove to be below normal, irrigation water supplies will be extremely limited, as has been the case the last 3 years. Normal snowpack would provide a fair water supply. However, a snowpack much above normal, coupled with good fall and spring rainfall, will be needed for a good water supply next summer.

NEW MEXICO—The flow of the Rio Grande was about three-quarters of average this season. Reservoir storage was very low at the beginning of the season. However, the use of groundwater and the occurrence of heavy summer rainfall combined to make a high crop production year. Eastern New Mexico enjoyed a good water year with average snowmelt runoff, full reservoirs and heavy rainfall on both the Tucumcari and Carlsbad irrigated areas. Streamflow on the San Juan River and its tributaries was slightly below average.

OREGON—Irrigation water supplies in Oregon during the 1961 season have varied from satisfactory in the northwest to exceedingly short in many southeastern areas. This is in reasonably close conformity to forecasts of water supply last winter and spring.

1962 water supplies for Oregon irrigators will be satisfactory only if much above average mountain snowpack accumulates during the coming winter season. Watersheds are all dry and will require heavy priming by rains to prepare for snowmelt to come next spring.

Stored water supplies in the majority of Oregon reservoirs are far below average for this season of the year. In some areas, notably in Malheur, Lake and eastern Klamath Counties, important reservoirs are empty. In other areas water supplies are now limited to stock water.

UTAH—As anticipated last spring, surface water supplies, both natural streamflow and reservoir-stored, were nearly exhausted by late July. Most mid-season and late crops suffered from lack of water. Some canals were out of water in early June. The more serious shortages occurred in northern Utah, where water rights as old as 1861 were shut off. Rainfall above normal during August and early September helped alleviate the extreme irrigation water shortage, making production considerably better than hoped for early in the year. Final production of all 1961 crops is still expected to be among the poorest for any year since the 1934 drouth. Farmers have done an outstanding job of stretching their meager irrigation water supply.

The rains of August and September have greatly improved mountain soil moisture conditions and prospects for a high yield from the coming winter's snowpack. Offsetting this picture for the large areas dependent on reservoir-stored water is the fact that reservoirs are practically empty.

WASHINGTON—Runoff this past spring and summer was extremely variable, but, generally speaking, streamflow was higher than the rest of the Columbia Basin. Reservoirs have held up and generally have more water in storage now than average.

At the end of the snow survey season snowpack at the higher elevations was good, but in the foothills was poor. The snowmelt was delayed. Streamflow was high in late May and early June. By the end of June streamflow had dropped to nearly half of what could be normally expected, with one station reporting only ten percent of the 1943–57 base period. This trend has persisted during the months of July, August, and September.

Irrigation interests which had to rely upon direct diversion from small streams have had to curtail their operations.

Valley precipitation since the month of May has been below normal, while temperatures have been above normal. The soil mantle on the mountain watersheds is extremely dry and unless there are above normal amounts of fall rain, a greater amount of snowpack than usual will be required next winter to wet the soils before the 1962 runoff can occur.

WYOMING—Snowmelt runoff from Wyoming watersheds was considerably less than average and close to the amounts expected. Reservoir storage throughout the state has been depleted to far below normal, especially on the North Platte.

Most of the State received heavy precipitation during May to supplement low mountain snowpack. However, this was followed by a drought that lowered the yield of early maturing crops.

In the south half of the State, August rain improved the yield of late maturing crops, but the Bighorn Basin and particularly the northeast section have suffered drought conditions.

Early snow storms during the latter part of September have improved soil moisture conditions in mountain areas.

# # #

FONTENELLE

A new community in Wyoming, Fontenelle, will be the construction camp on the Bureau of Reclamation's Seedskadee participating project of the Colorado River storage project and will later serve as operating headquarters. It is located 3 miles from the site for Fontenelle Dam, first feature to be constructed on the 58,800-acre irrigation project, and is 35 miles from Kemmerer, Wyo.

FORT SMITH

Fort Smith is the name of the construction camp and community being built near the site of the Bureau of Reclamation's Yellowtail Dam on the Bighorn River 45 miles southwest of Hardin, Mont. The Yellowtail Unit is a feature of the Missouri River Basin project.

Around the Corner

(Continued from page 100)

14,700 acres of irrigated farms in the Ashley Valley. In addition, municipal water will be supplied to the communities of Vernal, Maeser, and Naples. Steinaker Dam will provide the carry-over storage which will bring long-awaited relief from crops that dry up late each summer.

Under Construction

Florida Project, Colorado. Construction of Lemon Dam on the Florida River was started in 1961. First water deliveries are expected in 1964. Farmers on the 19,450-acre project area voted 315 to 1 in favor of the repayment contract—in favor of assuming the obligation to repay $1,775,000 in 50 years. This is eloquent evidence on the need for the Florida project.

Seedskadee Project, Wyoming. Some 58,800 acres of windblown, sagebrush grazing land will ultimately be transformed into 285 irrigated farms. Fontenelle Dam, the key structure located on the Green River, was started in 1961. Because of valuable trona deposits underlying the southern part of the area, the project will be stage developed. About 43,000 acres will be irrigated in the initial stage; development of the remainder will await experience with the subsidence which attends the underground mining of the trona deposits.

Smith Fork Project, Colorado. First water delivery is scheduled for 1963 to the 9,500-acre Smith Fork project. Located near the Paonia project, this supplemental water project will be served by the Crawford Dam and reservoir now under contruction.

Other Participating Projects

Preconstruction (advance) planning is under way on the Central Utah project (initial phase), Utah; Emery County project, Utah; Lyman project, Wyoming; and Silt project, Colorado.

Pending authorization are Navajo project, New Mexico (not to be confused with the Navajo Dam and reservoir which make this project possible); San Juan-Chama project, New Mexico; and Savery-Pot Hook project, Colorado-Wyoming.

The three projects for which feasibility reports will soon be ready for submittal to the Congress are Animas-La Plata project, an 84,500-acre project in Colorado and New Mexico; Bostwick Park project, a 5,600-acre supplemental water project in Colorado; and Fruitland Mesa project, a 23,450-acre project (mostly new lands) in Colorado.

# # #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5608	Smith Fork, Colo.	July 21	Construction of earthwork and structures for Smith Fork diversion dam, Smith Fork feeder canal, Aspen canal, Sta. 73+08 to end, and Clipper canal.	Riverside Corp., Farmington, N. Mex.	$385,300
DC-5610	Colorado River Storage, N. Mex.	Sept. 6	Construction of 182 miles of Glen Canyon-Shiprock 230-kv transmission line. Schedules 1 and 2.	Electrical Constructors, Columbus, Ohio.	4,854,544
DC-5611	Central Valley, Calif.	July 21	Construction of earthwork, structures, and surfacing for relocation of Trinity County road, Trinity dam to Buckeye Creek.	George W. Lewis, Kennewick, Wash.	500,316
DC-5614	Missouri River Basin, Minn.	July 26	Construction of Morris substation stage 01	Electrical Builders, Inc., Valley City, N. Dak.	342,912
DC-5535	Central Valley, Calif.	July 5	Construction of additions to Keswick power plant 230-kv switchyard.	Del Monte Electric Co., Inc., and Collins Electrical Co., Inc., Hayward, Calif.	231,383
DS-5571	Colorado River Storage, Utah-Wyo.	July 17	Three 47,000-kva power transformers for Flaming Gorge powerplant.	ASEA Electric, Inc., New York, N.Y.	288,290
DC-5576	Weber Basin, Utah	July 3	Construction of earthwork and structures for Willard canal, Willard pumping plants Nos. 1 and 2, and intake channel. Schedules 1 and 2.	Gibbons and Reed Co., Salt Lake City, Utah.	3,138,415
DS-5592	Colorado River Storage, Ariz.-N. Mex.	Aug. 16	2,240,000 linear feet of 1,272-MCM steel reinforced aluminum conductor for Glen Canyon-Shiprock 230-kv transmission line. Set aside portion for labor surplus area firms of Schedule 1.	Southwire Co., Carrollton, Ga.	1,010,240
DS-5601	Colorado River Storage, Ariz.-Utah.	July 26	Eight hoists and accessories for 13.96-foot by 22.45-foot fixed-wheel gates for penstock intakes at Glen Canyon dam and powerplant.	Pacific Coast Engineering Co., Alameda, Calif.	367,200
DC-5602	Lower Rio Grande Rehabilitation, Texas.	July 5	Clearing, and construction of earthwork, concrete lining, and structures for rehabilitation of B and D lateral systems.	E. & M. Bohuskey Construction Co., Harlingen, Tex.	567,456
DS-5603	Colorado River Storage, Utah-Wyo.	Aug. 24	Three generator-voltage switchgear assemblies and bus structures for Flaming Gorge powerplant.	I-T-E Circuit Breaker Co., Philadelphia, Pa.	102,772
DC-5606	Central Valley, Calif.	July 17	Construction of earthwork and structures for concrete pipe lines and laterals for Madera distribution system, Part 2 extension.	Sandkay Construction Co., Inc. and Ransome Co., Sacramento, Calif.	1,874,917
DC-5618	Colorado River Storage, Colo.	Aug. 4	Construction of 22.5 miles of Blue Mesa-Gunnison 115-kv transmission line.	Commonwealth Electric Co., Lincoln, Nebr.	442,041
DC-5621	Klamath, Oreg.-Calif.	Aug. 9	Construction of earthwork and structures for laterals and drains, Sump 3, Contract Unit 2.	Kenneth E. Beck, Moses Lake, Wash.	280,610
DC-5622	Central Valley Calif.	Aug. 15	Modification of Folsom outlet for Nimbus fish facilities.	Herrick Iron Works, Hayward, Calif.	275,416
DC-5623	Central Valley, Calif.	Aug. 21	Construction of 26 miles of Trinity-Clear Creek, Clear Creek-Keswick, and Spring Creek-Keswick 230-kv transmission lines.	John M. King Co., Tacoma, Wash.	1,312,374
DC-5626	San Angelo, Tex.	Aug. 30	Construction of earthwork, concrete lining, and structures for San Angelo distribution system.	H. B. Zachry Co., San Antonio, Tex.	985,174
DC-5634	Missouri River Basin, Mont.	Sept. 15	Construction of Clark Canyon dam	Emil Anderson Construction Co., Ltd., Square M. Construction Ltd., and Coleman Collieries, Ltd., Vancouver, B.C., Canada.	3,347,403
DC-5639	Uncompahgre, Colo.	Sept. 18	Construction of Ironstone diversion dam and Ironstone canal, Sta. (−) 1+15.11 to 6+48.	McGechie Construction Co., Inc., Cortez, Colo.	116,124
200C-480	Central Valley, Calif.	July 24	Construction of Trinity River fish hatchery	E-W Construction Co., Creswell, Oreg.	1,200,261
200C-481	Central Valley, Calif.	do	Clearing 3,240 acres of Whiskeytown Reservoir site	Ferd Drayer, Inc., Paradise Calif.	274,400
200C-483	Kalmath, Oreg.	Aug. 21	Construction of pumping plants Nos. 10 and 11, Sump 3. Schedules 1 and 2.	Klamath Plumbing and Heating Co., Klamath Falls, Oreg.	146,254
500C-108	Middle Rio Grande, N. Mex.	Sept. 15	Construction of roads, parking areas, and boat launching ramps; and furnishing and erecting picnic tables, shelters, and fireplaces for El Vado Reservoir recreational facilities.	Mulvaney Construction Co., Albuquerque, N. Mex.	123,123
DC-5638	Missouri River Basin, Mont.	Sept. 25	Construction of Barratts diversion dam, East Bench canal, Sta. 1+92.6 to 1302, and East Bench laterals 3.7 to 19.2 inclusive utilizing precast-concrete pipe for siphon barrels at Wilson and Carter Creeks.	Zook Brothers Construction Co., COP Construction Co., and Lewis Construction Co. Great Falls, Mont.	2,420,613
DC-5642	Missouri River Basin, Nebr.	Sept. 22	Construction of earthwork, concrete lining, and structures for section No. 1 of Ainsworth canal.	Missouri Valley Construction Co. Grand Island, Nebr.	1,152,989

Major Construction and Materials for Which Bids Will Be Requested Through November 1961*

Project	Description of work or material
Canadian River, Tex	Constructing a 27- by 78-foot brick veneer field office building, and furnishing and erecting a 30- by 56-foot metal laboratory building, including provisions for utilities. Work will also include a gravel parking area, an access road, septic tank, dosing tank, tile drain field, and fencing. At the Sanford Damsite, near Sanford.
Central Valley, Calif	Constructing about 19 miles of 12- to 30-inch-diameter pipelines, four earth-lined reservoirs, one concrete-lined reservoir, and one unlined reservoir. Alternate bids will be requested for concrete pressure pipe, prestressed noncylinder concrete pipe, pretensioned cylinder-type concrete pipe, asbestos-cement pipe, or mortar-lined and mortar-coated steel pipe. El Dorado (Contract Unit 3) pipelines, near Placerville.
Do	Clearing right-of-way, constructing footings, furnishing and erecting steel towers, and stringing Government-furnished conductors for about 22 miles of the Keswick-Gas Point Road-Cottonwood 230-kv, double-circuit transmission line. From the Bureau Switchyard at Keswick Dam to the PG & E Substation at Cottonwood.
Do	El Dorado Distribution System treatment plants: *Reservoir No. 1*—Constructing a 22- by 36-foot building and a 10- by 12-foot building, both of reinforced-concrete masonry units; a reinforced-concrete two-compartment mechanical mixer and flocculator tank with an approximate area of 1,250 square feet; a reinforced-concrete transition with an approximate area of 2,400 square feet from tank to reservoir; and installing water-treatment equipment. *Reservoir No. 7*—Constructing a 24- by 32-foot building of reinforced-concrete masonry units and installing chlorination equipment. Northwest of Sacramento.
CRSP, Colo	Constructing about 42 miles of the wood-pole, H-frame, Blue Mesa-Curecanti and Curecanti-Montrose 115-kv transmission lines. The 16-mile Blue Mesa-Curecanti line will use 477,000 circular mil (24/7) ACSR conductors, and the 26-mile Curecanti-Montrose line will use 556,000 circular mil (24/7) ACSR conductors, with two ⅜-inch, high-strength steel overhead ground wires to be installed for the entire length of the line. Vicinities of Sapinero to Cimarron and Cimarron to Montrose, Colorado.
Do	Furnishing and erecting a 2,300-square-foot laboratory and garage building, a 1,900-square-foot warehouse, and a six-stall garage, all of prefabricated metal, complete with water supply, sewage disposal, and electrical distribution systems. At the Blue Mesa Damsite, about 25 miles west of Gunnison.
CRSP, Utah	Completion work for the Flaming Gorge Powerplant will consist of constructing a switchyard, placing concrete for turbine embedment and generator support, installing three 50,000-hp. reaction turbines and three vertical-shaft, 36,000-kw generators, transformer bank, and other electrical and mechanical equipment, and applying architectural finishes and installing architectural features. At Dutch John.
CRSP, Ariz.-New Mex	Four each of eight types, 230-kv, single-circuit, guyed and self-supporting steel and aluminum towers for the Glen Canyon-Shiprock transmission line.
Columbia Basin, Wash	Constructing a 2,000-foot dike, 6,000 linear feet of boom with buoys and anchors at Lake Roosevelt, 20 miles north of Kettle Falls.
MRBP, Mont	Constructing three radio relay stations to provide communication coverage along the Yellowtail-Dawson County 230-kv transmission line. Work will consist of earthwork, concrete, furnishing and erecting steel buildings and steel towers, and furnishing and placing underground power and telephone cables.
MRBP, Nebr	Constructing the reinforced-concrete Red Willow Creek Diversion Dam with headworks consisting of a concrete overflow weir section about 100 feet long, a slide gate controlled sluiceway, and a slide gate controlled headworks structure. Near McCook.
Do	Earthwork and structures for about 9 miles of 10-foot bottom width canal, 1.5 miles of laterals, and about 5 miles of drains. Red Willow, near Indianola.
Do	Clearing about 100 acres of trees and brush from Red Willow Reservoir site, about 10 miles north of McCook.
Do	Earthwork and structures for about 120 miles of laterals with bottom widths varying from 8 to 3 feet. Farwell Main and Lower Main near St. Paul.
Do	Constructing a three-bedroom frame residence with attached garage, a 40- by 100-foot prefabricated metal office and storage building, and utilities. Near Ellis, Kans.
MRBP, N. Dak	Assembling and attaching insulator strings and hardware; stringing and sagging three 954,000 circular mil (45/7) ACSR conductors and two 0.5-inch, high-strength steel overhead ground wires on steel towers for a 3-phase, single-circuit 230-kv transmission line, about 136 miles long. Garrison-Jamestown, from a point near the Garrison Dam spillway to the Jamestown Substation.
Weber Basin, Utah	Earthwork and structures for about 15 miles of earth-lined canal with bottom widths varying from 10 to 6 feet. Layton canal, near Ogden.
Do	Constructing about 12 miles of 4- to 24-inch-diameter pipe laterals for heads of 100 to 450 feet. The pipe may be precast-concrete pressure pipe, pretensioned concrete, cylinder-type pipe, asbestos-cement pipe, cast-iron pipe, or mortar-lined and coated steel pipe at contractor's option within head classification limitations.
Wichita, Kans	Constructing about a 27- by 78-foot brick veneer field office and laboratory building (to be eventually converted to a caretaker's residence), and furnishing and erecting about a 20- by 40-foot metal storage building, including installation of utilities. Work will also include a gravel parking area, an access road, fencing, well and water supply system, and complete sewage disposal system, including a septic tank, dosing tank, and tile drain field. At the Cheney Damsite, about 25 miles northwest of Wichita.

*Subject to change.

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IRRIGATION OPERATORS' WORKSHOP

The Reclamation Era

FEBRUARY 1962

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In this issue . . .

VIOLET PALMER, Editor

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Drought Insurance FOR FARMERS

by FLOYD E. DOMINY
Commissioner of Reclamation

Because the weather has always been, alternately, adversary and ally of mankind, a definite drama and suspense obtain in climatic and water supply reports, lacking though these reports may be in traditional literary qualities. No one knows this better than the farmer in the Western United States. And probably no one knows better than he the importance of insuring against the vagaries of nature.

As the growing season unfolded during the past year, reports reaching Bureau of Reclamation headquarters in Washington showed once more that the most dependable insurance, when nature is stingy with precipitation, is provided by reservoirs and irrigation systems that supplement the supply of moisture in the soil.

The past year was the third in succession when precipitation was deficient over a wide area of the West—the fourth year in some places. Tersely worded weekly reports of the U.S. Weather Bureau carried ominous warnings even last June when unseasonally high temperatures and dry conditions prevailed. The September 1960 to June 1961 precipitation had averaged as low as 50 percent of normal over large areas in the Dakotas, Montana, and much of Idaho and Wyoming. Severe drought was likewise in progress in the California-Nevada-Utah region.

With subnormal runoff from snowmelt in the mountain areas, depleted soil moisture for seedbeds, and subnormal spring precipitation, large areas of the West faced critical growing season conditions. Climatologists and farmers know that drought is seldom broken in July—and the 1961 season proved this again.

Final crop reports from the far-flung drought areas reflected the spotty moisture conditions, as critical in some areas as the devastating droughts of the thirties. Widespread range and brush fires in California, near failure of harvests in parts of the Dakotas and Montana, sadly depleted pastures in other intermountain States—these effects spelled losses and hardship among countless dryland farmers and stockmen.

But this was not the first such dry season, nor will it be the last. The trick of living with the cycles of dry years and wet years, westerners have long since learned, is to build reservoirs of sufficient capacity to span the cycles, controlling the fury of flood, and reducing the sting of drought.

In the fabulous crop country of California's inland valley served by the Central Valley project, 3 consecutive dry years have passed without noticeable outward effects on the irrigated areas.

While range conditions were the poorest of many years, stock ponds dried up, supplemental feed shipments were necessary for range cattle, and dry-farmed grain yields averaged but 50 percent of normal, the stability of irrigation production buoyed up the agricultural economy. San Joaquin Valley reservoirs started this drought cycle with storage at 150 percent of the longtime average, and have been drawn down now to 40 percent, but will bounce back with a return to normal precipitation.

The severity of the recent drought is well told in the record for Lake Mead behind Hoover Dam—Reclamation's largest reservoir. July runoff of the Colorado River which feeds Lake Mead was only one-third of the longtime average and the second lowest on record. The water-year runoff turned out to be 43 percent short of normal. But the holdover storage capacity of this 30-million-acre-foot reservoir supplied the downstream irrigators the water they needed.

The last big drought of the pre-Hoover Dam era on the Colorado occurred in 1934 when the Colorado River discharge was only 4 million acre-feet and farmers in the Imperial Valley lost $10 million worth of crops.

Contrasting with depleted surrounding rangelands, the Kendrick project in Wyoming stood out as a prime example of the value of holdover storage. Only 4.8 inches of precipitation occurred in the May–September growing season. Of this totally inadequate amount, 1.2 inches came in a torrent, which had little good effect because of the rapid runoff, and 2.4 inches came as snow in late September, providing little, if any, benefit for crops. But reservoir storage enabled irrigators to mature good crops and to supply forage, grain, and grazing for livestock from the adjacent hard-hit areas.

Dusty scene from the 1930's is one that farmers want to insure against. Wise development of water resources is best insurance.

But it was in the northern plains and foothill areas where drought had its worst effects last year. The drought brought with it a common companion plague—grasshoppers. Unusually hot weather, and a buildup of drought in scattered areas over the preceding 4 years, made bad conditions even worse.

The U.S. Department of Agriculture declared much of the northern plains region a disaster area, and made farmers eligible for certain benefits and relief under authorized drought assistance programs. Rainfall was spotty, temperatures high. Rangelands dried up in June. Many fields of dryland grain were either cut for hay, pastured, or abandoned entirely.

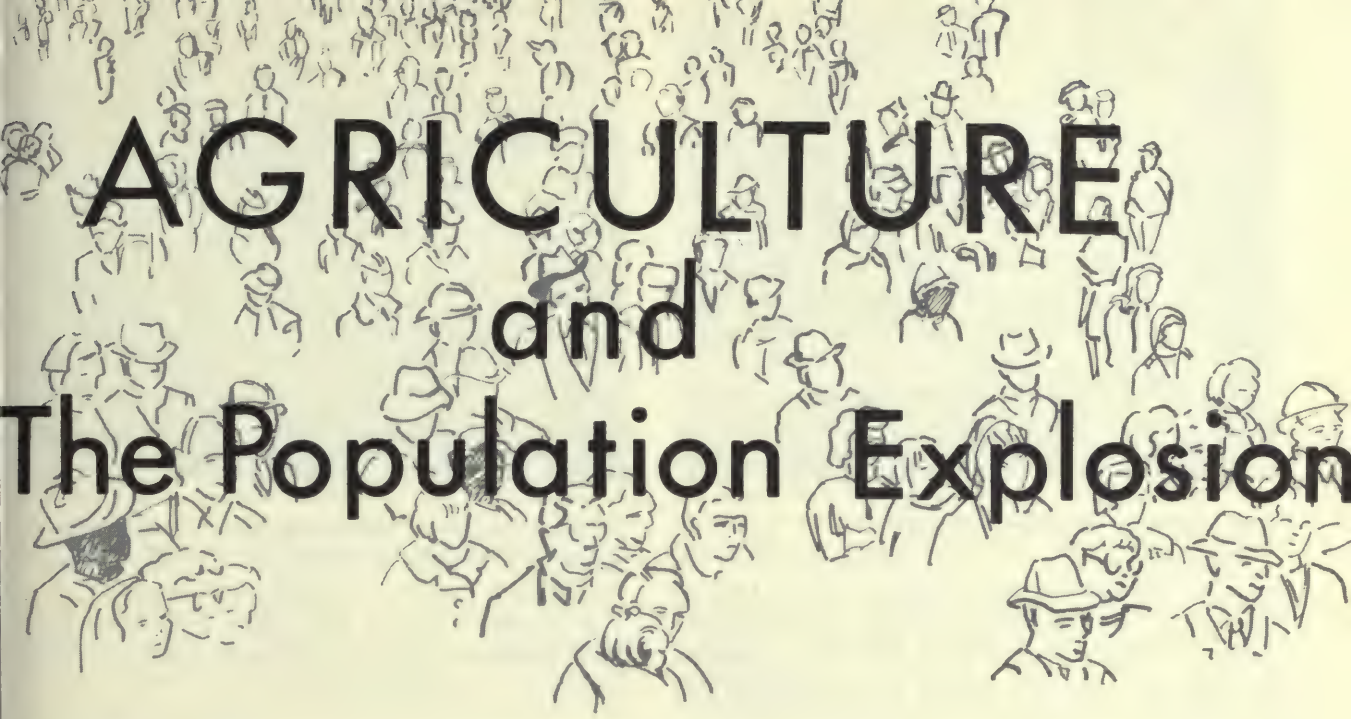
Such a severe moisture shortage can mean economic ruin for many farm families. The gains of a lifetime of toil can easily be wiped out. Although conditioned to pull through the usually dry and erratic weather patterns, the western farmers and ranchers finally go down fighting when the drought stretches out too long.

One North Dakota rancher who operates 100 acres of irrigated land for winter feed base was quoted as saying, "I will be able to keep my flock of 1,100 sheep and lambs intact this winter, thanks to alfalfa and corn silage produced under irrigation. I have no other feed and my range pastures look like they have been shaved." This was a typical situation, and under the emergency conditions that prevailed in 1961, the entire agricultural economy of many communities, farmers and townspeople alike, would have been in a serious plight without irrigation.

Without question, the keystone to economic stability in the western areas dependent on agriculture is reservoir storage. The development of the West could have stopped halfway had not the founders of the Reclamation program recognized the necessity of insurance against the erratic patterns of natural precipitation and unregulated streamflow. But however sound these pioneers knew the principle of holdover storage to be, we realize doubly today the true worth of a continuing program to store and conserve water. Succeeding generations of water users undoubtedly will rate this storage—this insurance against drought—at values we can now only imagine.

# # #

AGRICULTURE and The Population Explosion



Nothing in life is more constant than change. While we may accept this as truth, nevertheless it has been difficult for many of us to accept change in such a relentless rush as we have experienced since the end of World War II.

This pressure of growth has not been confined to the United States alone; it has been worldwide. In Great Britain, for example, one of the recent books that has attracted considerable attention is entitled "Cities in Flood." Obviously, the British are worried, as we are, over the single most spectacular aspect of postwar growth—the rapid expansion of our urban areas with all that this has meant in dislocations, tax problems, and other new pressures on our agriculture.

Uncontrolled urban sprawl has created unpleasant situations for both urban and rural people. Urban encroachment, particularly the leapfrogging type where housing developments suddenly spring up in the midst of farming land removed some distance from the previous city fringe, has tended to increase both taxes and operating costs for farmers. At the same time, their new urban neighbors are apt to be disenchanted with dust, odors, and flies which arise from surrounding agricultural operations.

We have more of these leapfrogging developments across country today than good planning and aroused community sentiment would have allowed. Perhaps it would have been impossible to arouse the necessary public sentiment at the height of the postwar rush to expand our cities. The centrifugal force applied by the need for new housing, the rising population, higher incomes, and the desire for suburban living probably would have broken down any opposition. But with better than 15 years of urban sprawl now behind us we can see the entire picture in better perspective and take better stock of what has been done.

It is certainly high time that more attention be given to planning in our growth and especially to protection for our fine agricultural lands which so often are found in the very areas where city expansion occurs.

Our bountiful yields of fruits, nuts, and vegetables are usually found in our coastal valleys, along our great rivers, and on the alluvial plains where good soil and water combine with mild climate. But these same areas are as attractive to people as they are hospitable to crops. And so it is that prime soils everywhere in the country have been lost to urban growth on an alarming scale in the past 15 years.

This situation is not limited to any one section of our Nation. It is true, however, that it has

by DR. DANIEL G. ALDRICH, JR.
University Dean of Agriculture
University of California

arisen with most spectacular and explosive force within the State of California where population has increased by over 6 million people since World War II and where that same period has seen some 1 million acres of farmland, often some of the finest, covered with homes, schools, freeways, factories, airports, and the like.

One California county, Santa Clara, which borders on the southern reaches of San Francisco Bay, may serve as an example of what has been going on. In 10 years, this county's population grew from 280,000 to 600,000. During that same period, its cropland shrank from 247,000 to 187,000 acres, a drop of nearly one-third. Agriculture still plays an important role in this county, but the subdivisions, industrial plants, and freeways are still reaching out for more land.

Since World War II, our concern has been for housing our growing population. As we look to the future, however, and assess the possibilities of the population explosion which has not yet reached its peak, we may well wonder when the time will come that we will be less concerned with housing people than with feeding them.

Are we headed toward an inevitable future when economic farmland is gone, when the squeeze turns the other way, on a hungry consumer paying the cost of growing food on poorer land? Could we reach a point, somewhere down the freeway we're traveling, where we'll bulldoze out tracts of houses and peel up the concrete of the shopping-center parking lots to get back our good land to feed our people?

I might say we can count on research, on our constantly improving farm technology, to keep up with the shift of agriculture to poorer lands. And we can. In spite of an exploding population, and a near certainty that this country will have 300 million people to feed by the year 2000, there's no question that agriculture can do it, even with much of the best land buried under pavement.

But each shift up the slopes from the valley floor pushes up the cost of growing food. *Someone must pay the higher cost.*

Rapid urban expansion—especially leapfrogging encroachment of housing developments on farmland—is roofing over best land.

Prune and apricot orchards give way to needs of urban community. When economic cropland goes, where will consumer turn?

Since World War II, concern has been to house people. Future may bring more concern with food. *(Photos courtesy author.)*

In the face of competition the farmer may absorb the costs of new technology and farming rougher lands. His alternative is to go out of farming. Eventually, though, the consumer will pay in higher prices.

All evidence tells us that the metropolitan community, with its cluster of satellites, is the future pattern of living for most of the people in this country. The evidence tells us pressure will continue around the borders of the cities. Some farmland—unhappily some of the best—must go out of agriculture, to bring the greatest good to the greatest number of people.

But uncontrolled urban sprawl, the leapfrog subdivision planted in the middle of farmland, and the octopus development stretching out in commercial clutter along the highways, these are *not* inevitable.

It is not inevitable that our level and fertile flatlands, our class I soils, must go just because they are easy to build on.

Zoning is the basic regulatory tool in community development. Through zoning, counties are trying to overcome the harassing problems so objectionable to agriculture and to preserve some of the rural "esthetic" values which people come to the country to enjoy.

Of course no master plan will satisfy all people. Farmers who hope to sell their land for urban development, either immediately or in the near future, generally object rather strenuously to zoning, since once land is zoned exclusively for agricultural use it can only be released to urban expansion by the local board of supervisors, who tend to follow the wishes of the majority in the community.

Master planning and zoning is not a program for land speculators. Instead, it is designed to achieve the goals desired by the people of the community. As such it generally does the most good for the most people.

Through zoning, which can be made to work with tax protection, our subdivisions, factories, and shopping centers can be channeled to the less productive soils. Superhighways, with their great swaths across the countryside, can skirt the class I and II cropland. Informed officials will see that the ultimate cost to the economy is less than the easy route down the valley floor.

Californians have seen a great defense plant go up in the rough hills east of our State capital. Housing has grown up around it on the same thin, rocky soil. We have seen our highway officials shift a freeway route, when its destructive cut through some of our richest valley lands was made clear.

These cheering moves show dawning recognition that there is no remedy for a built-over valley. Land must be protected before the damage is done.

An educated public and public officials can save our fertile lands for their best use—agriculture. Urban development can then become our reservoir of productive power while farms grow food and fiber where they can be grown most efficiently and at prices people can afford. # # #

Chemical Canal Sealants

From the Bureau of Reclamation's research laboratories in Denver comes the good news that chemicals which seal soils against water leakage hold promise of solving some of the water user's longstanding problems of economically reducing seepage of irrigation water from canals and laterals.

Working in cooperation with industry and water users' organizations, Reclamation research engineers and scientists are carrying out laboratory and field investigations which indicate that the bottoms and side slopes of canals may be successfully sealed by certain chemicals. The goal of this intensive research is threefold:

1. Find a low-cost lining for canals.
2. Find other effective and economical ways to reduce seepage from canals.
3. Find a way to seal water-filled canals that cannot be taken out of service, even briefly, for lining.

The Bureau has taken great strides forward in reaching two of the three goals. Under its Lower Cost Canal Lining Program, begun in 1946, the Bureau has made possible the savings of more than $20 million in the construction of linings for irrigation canals during the past 15 years.

More than 1,300 miles, representing 43 million square yards, of lower cost canal linings have been installed on Reclamation projects to prevent seepage of valuable irrigation water in its transit to irrigated areas. The importance of the 15 years of accomplishment is emphasized by the large savings in water as well as the savings in construction costs.

Coupled with the need for still lower cost canal linings is the challenge of the third goal—lining water-filled canals which, because of their vital importance to irrigation of certain projects, cannot be taken out of service to allow lining work to proceed. Here is where chemical canal sealants offer great promise.

Some sealants can be installed in a canal for 20 cents or less a square yard. In addition, recent field tests show that among these low-cost chemical sealants there are those which can be dispersed in flowing canals and will work their way down to seal the bottoms and side slopes of the canals.

Convenience and economy of application of the "one shot" sealants in the canal water have obvious advantages. Materials of this kind can be added to the water in a flowing canal. If irrigation schedules permit, the canal can be dewatered and temporary dams built to pond leaking sections for treatment with the sealant. By this "ponding" method, the sealant is maintained in contact with the subgrade soils of the canal for longer periods, thereby providing a more efficient seal than the "one shot" treatment.

In brief, chemical sealants make the canal subgrade impervious to water. When the sealants are

by L. M. ELLSPERMAN, Head, Bituminous Laboratory Section, Office of Assistant Commissioner and Chief Engineer, Bureau of Reclamation, Denver, Colo.

applied, they react chemically and/or physically to form either a solid or semisolid coating or deposit which precipitates to fill the voids in the soil. The sealants may be applied by a spray on the soil surface, by subsurface injection, or by addition of the chemicals to the canal water.

Although a host of chemicals have been tested to decrease the permeability of soils, most have not proved satisfactory, because they are dissipated through water movement in the soil, destroyed by micro-organisms, or reduced in effectiveness by erosion.

From these tests, Bureau engineers have established certain characteristics for the "ideal" canal sealant. It must not be toxic to humans, animals, or crops. It must reduce leakage to a minimum. It must resist damage by animals, equipment, and erosion. It must be durable and low in cost. At present, no material available will completely fulfill all of these requirements satisfactorily, although several commercially available products partially "fill the bill" for the ideal sealant.

Among the more promising sealants are emulsions obtained as byproducts of the petroleum industry. Some low-priced, fine-grained emulsions are made chiefly from wax, asphalt, and resins. In several laboratory tests, these materials penetrated sand to depths of 9 to 12 inches, stopping seepage through it. In a field test, canal subgrade soils were similarly penetrated, and measurements made before and after treatment with a petroleum-based emulsion indicated a reduction in seepage losses of from 60 to 90 percent.

Following these encouraging test results, a petroleum-based emulsion was tested along a 6.6-mile reach of the west side lateral of the Eden project in Wyoming in June 1961. The lateral is an unlined earth channel having a total length of about 12 miles.

The particular sealant used for these tests—which has a petroleum base—is still in the experimental stage and is applied in the form of an emulsion.

Seven insulated transport trucks, which rushed the emulsion from the refinery to the lateral site after a trip of 30 hours, were parked adjacent to the lateral. With three of the trucks as standbys, a 4-inch-diameter delivery hose from each of the

Emulsion sealant being introduced into flowing water of lateral at 400 gallons a minute. Inset shows 4-inch-diameter delivery hoses. Tests such as this give promise of seepage reduction.

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other four trucks introduced the emulsion simultaneously into the flowing water of the lateral.

All of the emulsion was pumped from the seven trucks into the lateral in 110 minutes. The following morning the "slug" of emulsion-treated water was observed at the lower end of the test section of the lateral.

Twenty-four hours after treatment, an exploratory hole was dug in the bottom of a treated sublateral adjacent to the main lateral. Water was carefully splashed on the exposed vertical side of the hole to wash away the fine sand and to determine whether a membrane lay underneath. About 6 inches below the surface, a membrane was detected; a secondary membrane was formed about 2 inches below the surface. The principal membrane appeared white and continuous in the area explored.

Water measurements made by Bureau engineers before application of the sealant showed that of the 27.7 cubic feet per second of flow entering the 6.6-mile reach of the lateral, only 7.92 cubic feet reached the lower end of the test section.

Measurements 24 hours after the emulsion was introduced into the water-filled lateral showed a reduction in seepage losses of 55 percent, and, 48 hours after treatment, the reduction was 66 percent. Reclamation engineers are determining the service life of the sealant in further studies.

Although results of the Eden project tests hold promise, no endorsement of the proprietary product is implied by the Bureau. Several other sealants are under study by Bureau researchers who are working in cooperation with industry and water users' organizations. These sealants include plastic and asphalt emulsions, resins, lignins (waste products of the paper industry), and cellulose.

A large-scale test is also being conducted on the Gila gravity main canal near Yuma, Ariz., using a second type of sealant which is commercially available.

A carefully controlled field test was in progress during the fall of 1961 on the Boise project near Notus, Idaho, utilizing three different types of sealant. In addition to the two chemical types mentioned, a new "cationic asphalt emulsion" is to be tested. Reclamation engineers will cooperate with members of the staff of the University of Idaho in obtaining water loss measurements before and after treatment.

The Bureau is continuing its research to determine the exact physical and chemical properties of sealants and the characteristics of combined soil, water, and sealants. From these investigations, Bureau researchers expect to determine the service life that can be expected from the sealants and develop standard specifications for reliable low-cost canal sealants which water users can use with confidence in lining their irrigation waterways.

# # #

Paper Waste Strengthens Concrete

A lowly waste by-product of the pulp and paper industry is being used to strengthen mighty Glen Canyon Dam under construction on the Colorado River in northern Arizona.

The ingredient is lignin (in the form of a calcium salt of lignosulfonic acid), which is used as an additive to the concrete mix for the dam. It serves as a lubricant, and Bureau of Reclamation engineers have found that this increases the plasticity of the mix and reduces the need for water, thereby increasing the compressive strength of the mass concrete about 10 percent.

Just as valuable, according to Reclamation Commission Floyd E. Dominy, is the ability of lignin to keep the fresh concrete plastic longer. This lets the motor-driven vibrators knit together upper and lower layers of concrete, allowing uniform texture and placement which are vitally important in any concrete structure.

Lignin is generally available from papermills and large chemical companies throughout the United States. It is received at Glen Canyon as a solution in tank cars. About 1 pound, by dry measure, is used per cubic yard of concrete.

The Bureau was among the early investigators and used lignin in concrete mixes for the Tecolote diversion tunnel on the Cachuma project, California, and the Glen Canyon diversion tunnel.

Commissioner Dominy said, "As part of our continuing research program, we have been studying water reducing agents—of which lignin is one—in the mixing of concrete for the past 9 years."

When Glen Canyon Dam is completed in 1964, nearly 5 million cubic yards of concrete will have been placed. The dam, at 710 feet, will be the second highest in the Western Hemisphere.

# # #

CONTROLLING *Wind Erosion*

by JOHN L. TOEVS, Associate Project Development Supervisor, Columbia Basin Project, Ephrata, Wash.

Most Columbia Basin project soils, after being pulverized in the process of leveling during a dry season, are vulnerable to wind erosion. On the medium textured soils, wind erosion control practices, such as furrowing and irrigation, then working of soil while wet, generally prove effective.

On the really light textured surface soils, control measures are more difficult and costly unless proper timing is practiced. Thus, it becomes highly important to reduce the time that the soil is left in this vulnerable condition and to so schedule the development and seeding operations that the soil is exposed the shortest time possible.

Fortunately, the most serious wind erosion problems on light soils of the Columbia Basin project occur in the initial phase of the development years. Even so, the loss of 1 year's crop can spell economic disaster to the average new settler, and irreparable damage is done to the soil. Ditches, both farm and project, are filled, increasing operating costs to the farmer and the project.

The weather pattern is variable from year to year. A relatively wet spring or fall is usually associated with less severe windstorms. On the other hand, dry seasons are usually associated with more wind. When farmers, particularly newcomers, initiate their development programs on the expectation of a repetition of a favorable fall or spring, they are inviting trouble.

The problem of wind erosion has been recognized by the Bureau of Reclamation, the Soil Conservation Service, and the Washington State University Experiment Station. While information on wind erosion control practices was available to the new farmer, it was thought that actual demonstrations on farms within light soil areas would be beneficial and could also lead to new techniques for controlling wind erosion. Therefore, these agencies entered into an agreement to conduct such demonstrations.

As soon as equipment can be operated without miring, seeding and preparing cloddy surface in one operation or practically simultaneously is essential, a day or two after water removal.

The first agreement provided for operation of a farm in irrigation block 15 from 1954 to 1956. Under this agreement, as under the present agreement, a committee of three representing the Bureau of Reclamation, the Soil Conservation Service, and Washington State University, are responsible for the planning and directing of the wind erosion program. The principal source of funds for these undertakings has been from the allocation of soil and moisture conservation funds available to the Bureau.

The first program was initiated on a Government-owned farm, a unit near the common boundary of blocks 15 and 16, both of which have a rather high percentage of light textured soils. The responsibility of carrying out the program has been with the personnel of Washington Irrigation Experiment Station and of cooperating agencies at the Station.

The selection of farm unit 203, irrigation block 15, was governed largely by the fact that (1) it had to be in Federal ownership to permit the expenditure of funds, and (2) in order to keep capital costs to a minimum, the unit should have a set of farm buildings. In this case, the unit had

Rye and vetch seeded in August being turned under the following May. Combination protects soil and adds organic matter.

been part of a dryfarm operation and the farm buildings were adequate and required only a minimum expenditure for repair.

A publication, "Wind Erosion Control," Stations Circular 268, by Stephen J. Mech, published by the Washington Agricultural Experiment Station and the Soil and Water Conservation Research Division, ARS, U.S. Department of Agriculture, lists timely hints on what can be done to control wind erosion.

The information contained in this publication was based on facts previously recognized and on experience obtained on the farm in 1954. The publication covers the following recommendations:

Cultivate when soil is wet to produce clods.

Don't till when soil is dry.

Use irrigation wisely.

Stripcropping is beneficial.

Ridging may help.

Crop residues are good protectors.

Native cover also can be used.

Don't develop more land than you can handle properly.

Level in late summer.

Avoid early land preparation.

The demonstration farm has since been sold under the Bureau's settler selection program to a young, successful family from Nebraska. The results and demonstrations were considered of sufficient value that, when in 1960 block 20 received its first water, a second wind erosion farm was established.

While Government ownership was again a controlling factor, there was no difficulty in selecting a farm unit fully representative of farms most vulnerable to wind erosion. No farm buildings existed on any Government-owned units in block 20. However, since farm unit 202, block 20, was located within one-half mile of Wahluke watermaster's headquarters, building requirements could be held to a minimum.

Farm unit 202 is located in an area that will and probably should be largely sprinkler irrigated. The soil is very light textured and frequently of limited depth on knolls requiring cuts equal to the depth of the soil when land is leveled. Under such conditions, leveling costs run high because of the need to undercut and backfill with good soil material. Nevertheless, it was decided to level approximately 25 acres, which, by the way, did require considerable undercutting for surface irrigation in order to compare water use and water application problems on light-textured soils having a high infiltration rate.

Another feature on this farm unit which is quite common in many farm units was the presence of class 6 land so located among irrigable land that it would be difficult to bypass without leaving out land classed as irrigable. This area required some leveling to permit the use of wheel-move sprinklers. From 75 to 90 percent of all new sprinkler installations in recent years on the Columbia Basin project have been wheel-moves.

The development and operation of this farm have been under a new agreement between the same three agencies and with the same responsibilities as in the former agreement.

Results with respect to the development of the farm and the establishment of protective vegetative cover during the less windy season have been exceptional and of real demonstrational value.

The portion leveled for gravity irrigation in late July and early August had been preirrigated with sprinklers. This provided better working conditions and better compaction in the fill areas.

The area was then surface irrigated and seeded to rye and vetch during August, with one strip seeded to vetch and another to rye alone. The rye-vetch combination is preferable.

Rye alone provides quick fall growth and is effective against wind erosion but has low fertility value when turned under the following spring. Vetch alone is not recommended because it does not survive occasional severe winters, thus leaving

Continued on page 26

The Fiery Ordeal of San Dimas

by K. FRITZ SCHUMACHER[1]

Conservation of water and protection of watersheds are complementary endeavors. Carried on though they are by various agencies and organizations, the goal is a single one—wise development of resources for the optimum benefit of all the people now and those to come in future generations. Watershed protection and improvement are especially important when the development of water resources is viewed on basinwide terms. From the standpoint of Reclamation, foremost among the many benefits of good watershed management is the increased water yield it affords.

July 20, 1960, was a blistering 107°, a southern California scorcher of low humidity. Lightning struck a telephone line in the East Fork of San Gabriel River and traveled to Johnstone Peak before grounding. The line thus became a lighted fuse to set off an explosive mixture of tinder-dry timber and brush. The Johnstone fire burned out of control for several days and spared none of the 19 watersheds of the San Dimas Experimental Forest.

Laboratory and residential buildings in the Tanbark Flats area were hastily evacuated. After the first searing onslaught, firefighting crews moved into the area in force to save man-made improvements. However, 15,000 of the 17,000 acres of experimental forest received a scorched earth treatment more thorough than could be inflicted by an enemy bent on total destruction.

The San Dimas Experimental Forest was established in 1933 by the Forest Service, U.S. Department of Agriculture, in cooperation with the State of California and local agencies concerned with water supply for the mushrooming communities of semiarid southern California. The purpose is to study rainfall, streamflow, and groundwater movement to determine the type of forest ground cover most effective in preventing erosion and least demanding on precious water supplies.

The area dedicated to this study is in Angeles National Forest, north of Glendora, Calif. It includes Big Dalton and San Dimas Creek drainage basins on the southern slope of San Gabriel Mountains and is separated from the main mountain mass by deep canyons, which prevent groundwater infiltration from adjoining basins. Los Angeles County Flood Control District maintains reservoirs at the mouth of both canyons and keeps records of total runoff and sediment deposit.

The San Gabriel Mountains, composed of highly fractured and deeply weathered rock resting more steeply than the angle of repose, are among the most unstable mountains on earth. Generous rainfall of high intensity at peak elevations, which can cause debris-laden floods, poses an ever-present threat to foothill communities.

The Johnstone fire brought all current experiments to a sudden, spectacular end. Actual financial loss was estimated at about $450,000, but no

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[1] **Mr. Schumacher, who has as one of his avocations the writing of articles such as this, is a hydraulic engineer with the Water Resources Division, U.S. Geological Survey, in the Los Angeles Subdistrict office.**

amount of money can restore the interrupted experiments.

A reappraisal of research objectives was in order. At the same time, a challenging, golden opportunity was presented to the Forest Service. The fire offered a once-in-a-lifetime opportunity to measure erosion losses from watersheds thorougly studied under normal conditions. It emphasized the urgent need for developing methods of emergency erosion control. Fires of the exceptionally dry 1960 summer burned more than 10 percent of the Angeles National Forest. There was no time for lengthy scientific research into erosion control before the advent of winter rains.

In 1953 a moderate rain fell on a 1,500-acre watershed, one-third of which had burned the previous fall. The Forest Service observed a flood peak 68 times normal which increased erosion 30 times. Similar observations in Arroyo Seco, a few miles to the west, showed that on steep, burned-over slopes, dry creep erosion is increased from 2 to 35 times the preburn rate and exceeded normal waterborne erosion.

Emergency sowing of rye grass or black mustard seed in the devastated area, soon after a fire, has long been the practice in southern California. Distributing the seed by helicopter over large areas at a rate of 10 pounds per acre costs $1.60 per acre. The effectiveness of this treatment to reduce the amount of sediment in stream channels has never been quantitatively measured. The burned watersheds of the experimental forest should serve admirably for this purpose.

Many refinements are possible with different types of seeds, both mixed and unmixed, and with various methods of distribution. Annual grasses are inexpensive, fast growing, and reseed themselves readily. It is proposed also to test the use of deep-rooted perennial grasses at altitudes too cold for annuals.

On some plots regrowth of chaparral is being deliberately arrested by herbicide sprays in order to let grass take over. The ideal ground cover varies with slope and soil depth. Native chaparral has the deep, ground-stabilizing root system needed on steep slopes. Its extreme inflammability is a serious disadvantage.

This test should answer, on a watershed basis, a question of long standing. Will a shallow-rooted plant, which permits percolation through its root zone, yield more water for ground-water recharge?

The possibility of breaking up large inflammable stands of chaparral with wide fuel breaks of grass is being investigated. Such fuel breaks are more effective and easier to maintain than the narrow cleared firebreaks now in use. They also make threatened areas more accessible.

Mechanical methods of erosion control are being tested in nine watersheds. In these areas, terraces

Continued on page 26

Contour basin terraces are constructed to intercept runoff and eroded material. ***(Photos by Forest Service, USDA.)***

Notes from Irrigation Operators' Workshop

Part I

This is the first of a series of four articles highlighting for readers of *The Reclamation Era* the main topics discussed at the Irrigation Operators' Workshop, held in Denver the week of December 11–15, 1961. Eighty representatives from irrigation districts on projects of the 11 Northern States of the Reclamation West participated in the discussions.

The participants, divided into four groups for roundtable discussions, conferred on seven broad technical subjects—concrete placement and repair practices, earth construction practices, water management, protective coatings, weed control, equipment management, and pump maintenance. This article summarizes the discussions on the first two topics, concrete placement and repair and earth construction.

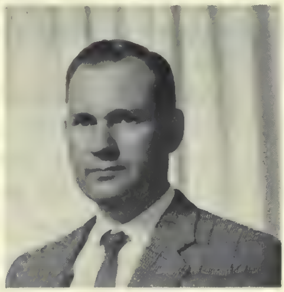
Six engineering specialists from the Bureau's Engineering Laboratories led the discussions on concrete and earth work. They were E. C. Higginson, G. B. Wallace, and L. J. Mitchell, of the Concrete Laboratory; and W. G. Holtz, A. A. Wagner, and H. J. Gibbs of the Earth Laboratory.

The specialists of the Concrete Laboratory emphasized the importance of control of concrete mixing and placement in operation and maintenance work. They pointed out that the objective of concrete control is that concrete placed for new structures or for repair of older structures be uniform and amply serviceable in quality *at minimum cost.*

Minimum cost, in other words, means "be practical"; money should not be spent on needless refinements that will not add to the useful performance of the structures.

In discussing uniformity in concrete construction, the laboratory engineers explained that as the chain is no stronger than its weakest link, so the concrete structure is no better than its poorest material; if the structure does not fail from overstress, it may fail from weathering or other deterioration of some poorly made part. Therefore, the operation and maintenance supervisor, and the water user, too, should be particularly

LEONARD J. MITCHELL



GEORGE B. WALLACE

ARTHUR A. WAGNER

HAROLD J. GIBBS

concerned with batch-to-batch and day-to-day uniformity in concrete construction and repair.

Uniformity of aggregates (sand and gravel) *as batched* lies at the foundation of good concrete work. The most efficient concrete is that having the minimum cement and water contents for adequate workability, sufficient strength, good durability, and other essential properties. Unless aggregates are clean and uniform in grading, an appreciable extra margin of cement, sand, and water must be provided to insure workability and quality under all conditions.

On each job, large or small, the cement for concrete work should be uniformly and accurately measured for each batch. The cement should be fully protected from the weather, and care should be taken that it is not lost in the wind in various handling operations.

On well-controlled jobs, the laboratory engineers told the workshop conferees, aggregates for concrete are batched by weight. One facility for weight batching may be platform scales for wheelbarrows, where concrete is batched and mixed at the forms for such structures as small canal turnouts.

The batching of water and the dispensing of small quantities of admixtures to improve the mix are other important functions in the assembly of materials for each batch. Batching and performance of the mixer used can be checked to some degree from the appearance of the freshly mixed concrete.

Uniform distribution of ingredients indicates effective mixing; good texture and cohesion of the mix indicates the mixing is properly timed; and the uniformity of the slump of the mix is evidence of the uniformity of the materials and of the batching.

Since forms are a poor medium for curing, and form surfaces will usually be found dry when they are removed, it is desirable to remove forms at the earliest time concrete will not be damaged, so that curing may be started as early as possible.

Prevention of moisture loss before the concrete hardens is very important, the laboratory engineers emphasized. Ideally, the concrete should be kept continually wet for several weeks from the moment it is hard enough not to wash under flowing or spraying water; then it should dry before it is subjected to low temperatures.

Portable wheelbarrow scale provides an effective means for securing

Finished gutter drain is being sprayed with membrane coating for curing concrete. Proper curing is important for strong concrete.

on small jobs. On well controlled jobs, aggregates are batched by weight.

On some work, at least 14 days of water curing is practicable by use of soil-soaker hose, burlap or cotton mats, wet earth blankets, or other methods. At the end of such a curing period, concrete should be protected from rapid dryout for best assurance against cracking from shrinkage or drying.

The three Concrete Laboratory engineers summarized their discussions by defining the properties of good quality concrete which irrigation operators and water users should strive to attain in their concrete construction and repair work.

Good, uniform concrete should be strong, durable, and economical. To achieve strength, the mix should, among other qualities, have a low water-cement ratio and structurally sound aggregates and be adequately cured. For durability, the concrete should be resistant to weathering, wear, and chemical action. For economy, the concrete should have a good grading of materials, equipment used for mixing should be dependable and adequate for the job, and the mix should be uniformly workable and consistent in texture to allow for ease of handling and placement.

Earth Construction

The engineer trio from the Earth Laboratory discussed three broad topics in earth construction practices—properties and selection of earth materials, foundation considerations, and earthwork construction procedures.

Workshop participants were told soils are important materials in Reclamation construction and that Bureau engineers study the physical properties of soils to help them in design and construction of foundations and earthwork. The engineers are interested in the density of soils, their permeability, shearing strength, compressibility, and interaction with water.

Irrigation operators should have some understanding of the method of identifying soils and classifying them into categories or groups which have distinct engineering properties. The various soil types were described in detail, simple identification methods were given, and the engineering uses for the soils so identified were discussed. Understanding of the recognized soil types also enables engineers in the design office and all those engaged in fieldwork—the engineer,

Earth core, being extracted from cylinder, will be subjected to various tests. Thorough analysis of construction materials is must.

the irrigation operator, and water users—to speak the "same language."

Emphasis was given to the important fact that soils are investigated for borrow materials, for embankment or for backfill, and for foundations for structures. For economy, maximum use should always be made of the excavated material in the construction of embankments and for backfill.

A foundation area, therefore, often becomes a source of material, and the investigation of the area must take into account its dual purpose. Description of soils encountered in such explorations must, in turn, contain the essential information required both for borrow material and for foundation soils. The ability to identify and describe soils will pay big dividends later in safe, efficient, and economical construction and repair.

An understanding of foundation conditions—the ability to discriminate between sound and unsound foundations—will also be rewarding, the Earth Laboratory specialists pointed out. The conditions for which the adequacy of a foundation should be established may include stability, settlement, expansion, and permeability. These four essential elements of foundation investigations and evaluation were discussed in detail, and their importance in construction and operation and maintenance work was stressed.

Discussions on foundation problems embraced clays, silts, sands, and gravelly soils. Also discussed were solid rock foundations, overexcavation and replacement, and special foundation requirements.

Earthwork construction procedures of interest and importance to irrigation operators came under intensive review during workshop sessions. Discussed were the three types of fill construction—embankments, linings and blankets, and backfill.

Embankment construction applies primarily to laterally unsupported fills built on top of the natural ground surface; lining and blanket construction applies mainly to relatively thin sheets of fill spread over an area either of natural ground or embankment; and backfill refers to refill of holes excavated below the ground surface, or earth placed in confined spaces and against rigid structures.

Underscored were the principal types of embankment construction—dumped fill, selected fill, equipment compacted fill, rolled fill, blended earthfill, stabilized fill, and hydraulic fill.

Of particular interest to participants in the workshop were the discussions of the variety of earthwork problems found in canal and lateral construction and repair. The laboratory engineers explained that because of the great extent of canal work, many different kinds of earth foundations and materials are encountered.

Some reaches of a canal may require nothing but uncompacted embankments made of unselected materials excavated from the prism; other sections may require careful control of cuts in borrow areas, strict moisture control, and compaction of earth in the form of linings or entire embankments.

The Earth Laboratory engineers concluded their sessions with a strong appeal to the workshop's irrigation operators to be ever aware of the importance of control in earthwork construction. In contrast to other types of construction, in earthwork it is common practice to use material that is available locally rather than to specify a particular type of material of specific properties. Likewise, there is usually a variety of procedures available by which earth materials may be satisfactorily incorporated into a structure. # # #

Test pit for concrete aggregates has been hand dug and gravel and sand arranged in various sizes. Uniformity is essential.

RECREATION

Southwestern Nebraska's NEW INDUSTRY

While the benefits of water-based recreation in terms of individual enjoyment and health are reason enough to consider it a national asset, it has become even more than a matter of pleasure. It is a business, too—an industry that provides employment and contributes to the Nation's economic strength. This relatively new recreation industry—given impetus in the West by man-made lakes—is described in the following article.

Reclamation lakes in southwest Nebraska, boasting 10,000 surface acres of water, have attracted a multimillion dollar industry—recreation. The impoundments drew over 400,000 visitors last year to enjoy boating, water skiing, swimming, camping and hunting, and the ever popular and predominant sport, fishing.

The phenomenal story we have to tell involves a nine-county area containing 17,500 square miles, populated by nearly 46,000 people. This large expanse, located in the heart of the treeless high plains, is transected by the Republican River and its tributaries, and is bounded on the south by Kansas and the west by Colorado. Within the area, there are numerous small agricultural towns and a few small cities, the largest being McCook, Nebr., with a population of 8,300.

In the late thirties and early forties, drought and devastating floods seriously crippled the area. Being experienced pioneers in hardship, the people decided to fight back at these problems and began to seek State and Federal help.

In the early planning and construction stages of the large dams being built for flood control and irrigation storage, very little consideration was given to what has proven to be a very important use of the reservoirs—recreation.

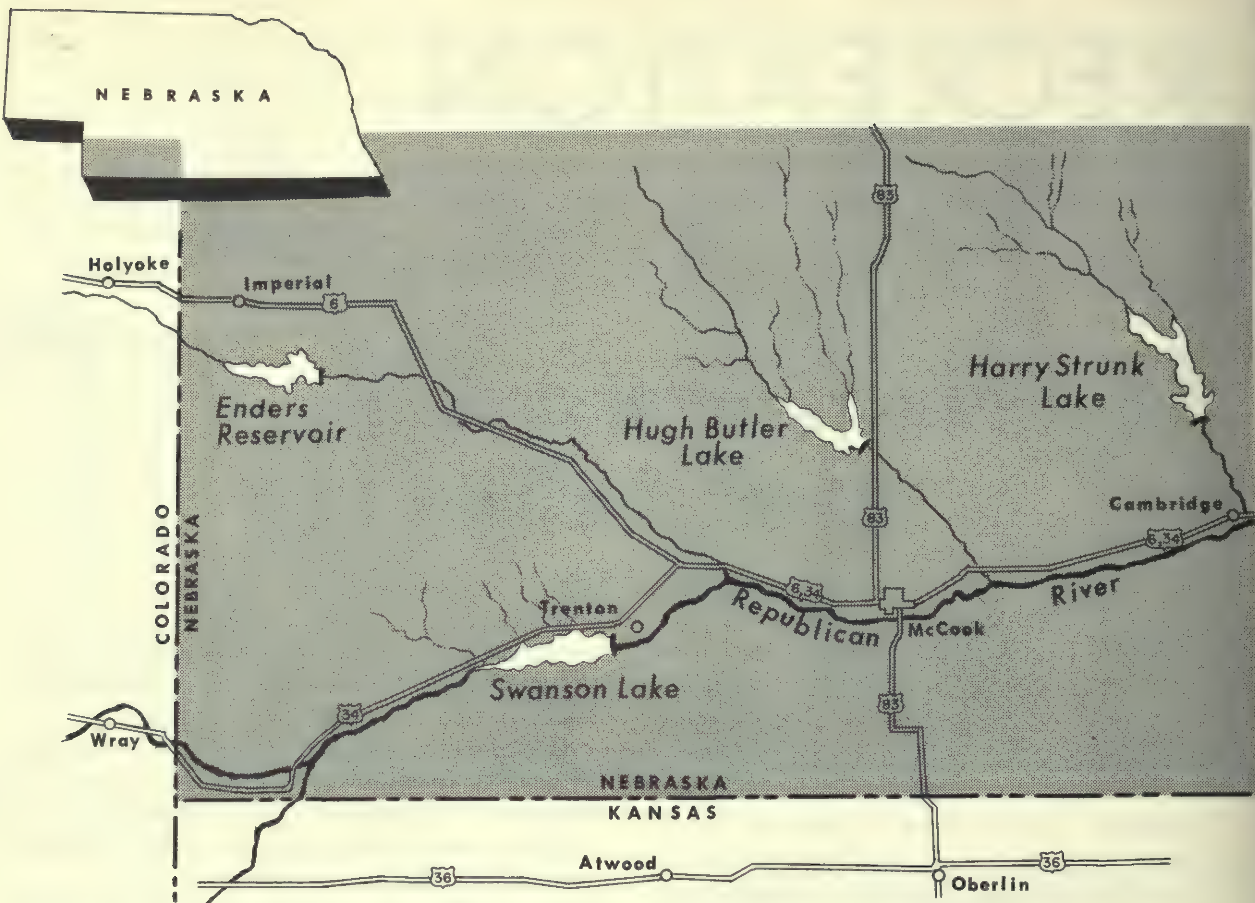
If the Federal and State planners and prospective water users could have gazed into a crystal ball, even ahead a few years, they would have seen a vision to quicken the heart of many outdoor enthusiasts—boats by the score plying the waters of these newly created lakes, campers, picnickers, swimmers, water skiers, fishermen and hunters abounding everywhere.

The rapid transformation of the landscape and social habits of the people and the quick change in economic conditions started with construction of the Frenchman-Cambridge Division, Missouri River Basin project, in the late 1940's. Enders Dam and Reservoir, Medicine Creek Dam-Harry Strunk Lake, and Trenton Dam-Swanson Lake were completed and filled in the early 1950's.

A fourth and very promising attraction for recreation seekers, Red Willow Dam-Hugh Butler Lake, is under construction and will be completed in 1962.

During construction of the first of these three big dams and reservoirs, only minimum basic

by RALPH F. BUSH, Agricultural Economist, and DEAN M. SCHACHTERLE, Management Agronomist, Bureau of Reclamation, McCook, Nebr.



facilities were planned—to take care of the sightseers and an occasional fisherman and to provide protection for Reclamation facilities. It was not expected that the reservoirs, located in a lightly populated section of the high plains, would attract many visitors.

Time, however, has proved this viewpoint wrong. In keeping with national trends after World War II, a virtual "recreational explosion" occurred around the new lakes in the Republican Valley. They opened up a whole new world of activity. Now, lines of cars, many trailing boats, head for the lakes on summer weekends and holidays.

It is rather ironic that the city of McCook, which could furnish only one boat (or so it has been reported) for rescue operations during the 1935 flood, now seems to have virtually reached the stage of "a boat in every garage."

The minimum recreation facilities, constructed with the dams and reservoirs, were greatly overtaxed. Fortunately, the Bureau of Reclamation, the National Park Service, and the Nebraska Game, Forestation and Parks Commission worked out a cooperative program which has in a large measure eased the pressure.

The recreation now being administered under the able direction of the latter Commission, although timely and highly successful, is too modest to meet the full impact of this newly created industry.

Paul H. Berg, project manager for the Kansas River Basin, in whose area these lakes are located, was convinced that there should be a "new look" at the recreation potential for Reclamation projects in the planning stage. To obtain necessary information, he instigated a study to measure the use being made of Reclamation lakes in southwest Nebraska. When the study was first being discussed, Mr. Berg remarked, "We need to know how significant are the recreation benefits, and what part they should play in project justification."

Consequently, the Bureau of Reclamation consulted with the National Park Service and it was agreed that a comprehensive and unbiased study should be made by the University of Nebraska. The National Park Service then contracted with the university to collect vital information to determine the extent of the economic and sociological impact attributable to recreation on the three

southwest Nebraska lake areas. The study was made during 1958 and 1959 under the guidance of the Council for Community Study and was directed by Dr. Edgar Z. Palmer, director of the university's bureau of business research. Dr. Richard Videbeck, of the department of sociology, assisted in the sociological phases of the study.

The university developed an informative report[1] containing numerous sidelights on the extent and variations in the recreational uses of the lakes. Over 3,000 questionnaires were sent to persons living in southwest Nebraska and northwest Kansas, and scores of people were interviewed during the summer recreation season by trained personnel.

The detailed surveys made of business establishments revealed that many new ones had moved into the area to furnish the special services and equipment demanded by outdoor sportsmen. The more noticeable ones are sporting goods stores that sell boats, motors, fishing equipment, guns and ammunition, and all kinds of camping paraphernalia.

The construction industry—both within the towns and cities and along the lake shores—has also thrived as a result of the lakes. This can best be illustrated by the 22 cabins that have been constructed in the Enders Reservoir seasonal cabin area and the 19 cabins attractively blending into the landscape of Harry Strunk and Swanson Lakes.

To furnish the many necessities that are forgotten at home, or when an emergency arises, concessionaires operate facilities at Swanson and Harry Strunk Lakes. They supply such goods and services as bait and fishing equipment, boat and motor rental, boat repair, parking space and necessary utilities for house trailers, and short order meals. They also serve as information centers for tourists and new lake visitors.

Why have the many new business ventures been attracted to southwest Nebraska since the lakes were built? Dr. Palmer found that almost $1.4 million is spent annually in the area in connection with recreation at the lakes, plus another $1.2 million spent elsewhere. These expenditures generate another $2 million derivative business associated with the direct recreation spending. He also found that $1.4 million spent in the area is providing work for 50 persons directly, plus another 70 indirectly. This means that about 300 persons in the immediate area, including families of workers, are supported by the recreation business generated by the lakes.

"This is not the only economic benefit from the lakes," says Dr. Palmer. "The presence of recreational facilities is an important factor in making a region attractive, and water is one of the most important types of such facilities in this regard. Prospects for the establishment of industry often inquire concerning the quality of such facilities in deciding whether to locate in a given community." # # #

[1] **Recreational Aspects of Three Nebraska Lakes, Community Study No. Three—Edgar Z. Palmer, University of Nebraska.**

Part of southwest Nebraska's new recreation industry is well illustrated by increased sales in the sporting goods business.

Semiautomatic Irrigation

by GERALD COSTEL[1], Supply Instructor, Agriculture College, University of Wyoming

The need for increasing water-use efficiency is becoming ever more important in all facets of Western United States economy—industrial, agrarian, and domestic.

While this problem affects all in general, it is a critical one for the operators of irrigated farms and ranches because (1) efficient use of irrigation water requires a great deal of labor and this type of labor is extremely scarce, and (2) if labor can be found it is, in most instances, too expensive to be supported by returns from the land.

Clearly the need for automation, in these circumstances, is a pressing one. In October 1959, O. K. Barnes of the University of Wyoming Agricultural Extension Service staff, asked the Agricultural Engineering Section if it could devise a semiautomatic surface irrigation system for the University Pilot Farm at Farson, Wyo. The following factors and requirements for that area were known:

1. Sandy soils with an absence of a usable water table predominated.
2. Soil and other conditions required irrigation cycles of 7 to 10 days.
3. Borders were 50 feet wide and vary in length from 450 feet to 1,100 feet, requiring variation in time of application from 40 minutes for the shortest border to 80 minutes for the longest border.
4. A water application of 3 cubic feet per second was adequate for these soil conditions.
5. The irrigation system featured raised ditches. Stationary siphons were (and still are) in general use.
6. These ditches were built on a railroad fill which gave an average of 12 inches of head from water surface to the land surface when the ditch was checked.
7. The configuration of contour ditches was 7

[1] In his work on development of the irrigation siphon, the author expresses appreciation for the financial aid given for the project to the College of Agriculture by the Wyoming Natural Resource Board and the Bureau of Reclamation and for assistance from Glenn A. Hood, Dr. Clarence F. Becker, and Robert D. Burman, of the Agricultural Engineering Section, University of Wyoming.

feet top width, 1½- to 1-foot side slopes, and 2½ feet bottom width.

8. For efficient irrigation a continuous labor force was needed 24 hours a day.

9. To be economical, an operation had to include 240 acres of irrigated land in hay, small grains, and pasture handled by one man.

10. The semiautomatic irrigation devices currently available were too costly for the type of cropping practices suited for this area.

With these factors in mind, we reasoned that a traveling siphon would be the simplest and most economical means of applying water to the borders. The final product, developed after 2 years of research, is the water-powered traveling siphon. It is capable of delivering 3 cubic feet per second with a head of 13 inches from the water surface in the ditch to the land surface on which the track runs.

An earlier model consisted of two commercial stationary siphon tubes. These parallel tubes were joined with a float at the ditch end. Mobility was provided by an automobile wheel and tire powered by a one-cylinder gasoline engine placed between the tubes at the discharge end.

To correct certain disadvantages of this model, the present model was made lighter, weighing about 280 pounds, compared to 450 for the old model. The reduced weight was made possible by custom designing the driving parts, replacing the automobile wheel with a cleated track, and using one tube instead of two. The new model, which is almost exclusively aluminum, has a higher, longer arch than the old one, to fit the ditch bank.

Waterpower Replaces Gasoline Engine

The addition, to the new model, of undershot turbines at the discharge end provided control of the water discharged and at the same time furnished the power to move the siphon along the ditch. Thus, the power furnished by the force of the water precluded the need for gasoline-engine power.

The cleated track, replacing the wheel, has improved traction, particularly through mud and water, and eliminates the possibility of high-centering.

Late model siphon, foreground, contrasts with earlier model. Tube is streamlined; turbines and cleated track replace engine and wheel.

The irrigation device is capable of negotiating S-turns and other irregularities found in contour ditches. The siphon gains canal guidance through the action of the rigid "T" formed by joining the pontoons to the siphon. The unit is continuously in motion, traveling at preselected speeds variable from 0.5 feet per minute to 1.5 feet per minute.

The length of continuous run is governed only by spacing of permanent obstructions, i.e., checks or drops, that the siphon cannot negotiate. Therefore, in a system designed especially for the traveling siphon—with a relatively flat ditch, equal-length borders, and checks properly spaced—it is possible to leave the siphon unattended for periods of 8 to 12 hours or more.

As an example, scheduled minor ditch modifications at the Farson Pilot Farm will allow unattended runs of 10 to 12 hours. These modifications will include installation of permanent checks at strategic locations.

The tests conducted to date, even though not complete, indicate that the traveling siphon offers promise of reducing labor costs of irrigation. The siphon, however, is yet untested and unproved under conditions other than those at the Farson Farm. Its performance on soil types and ditches in other parts of the West are unknown. # # #

Author points out details of irrigation siphon, left hand on cleated track that gives improved traction. Undershot turbines provide power to move siphon. ***(Photos courtesy University of Wyoming.)***

United States Department of the Interior

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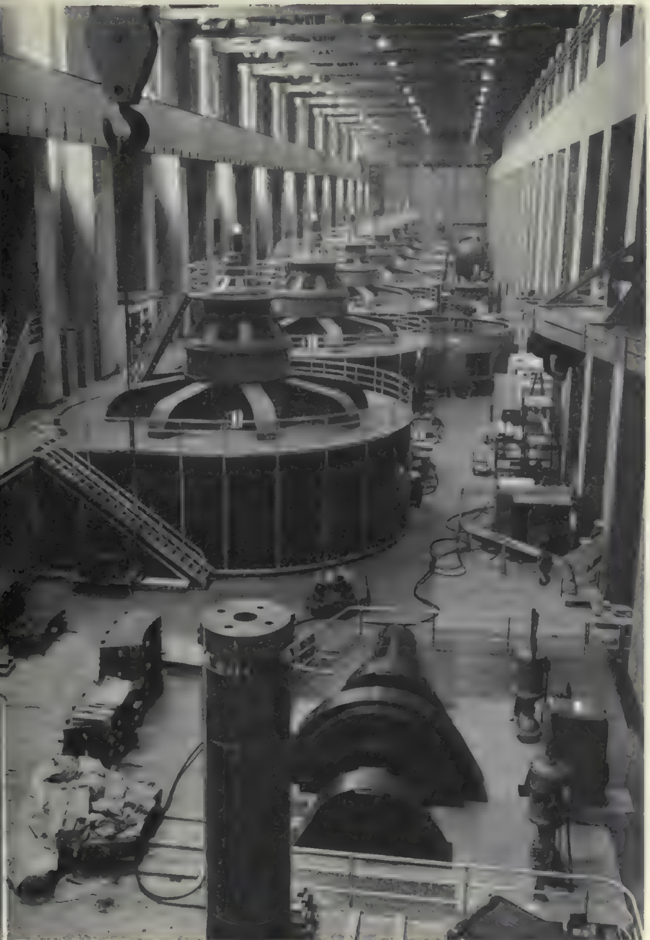
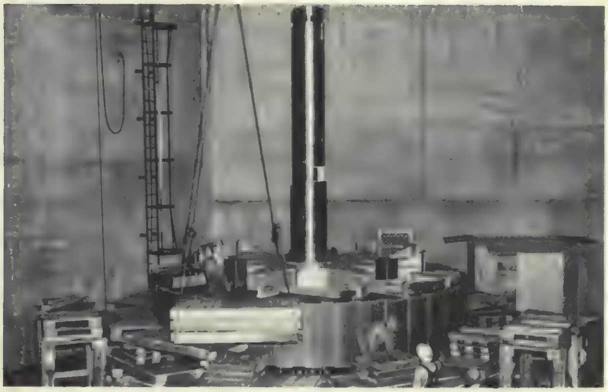
REGION 7: John N. Spencer, Regional Director, Building 46, Denver Federal Center, Denver, Colo.

Reclamation Milestones



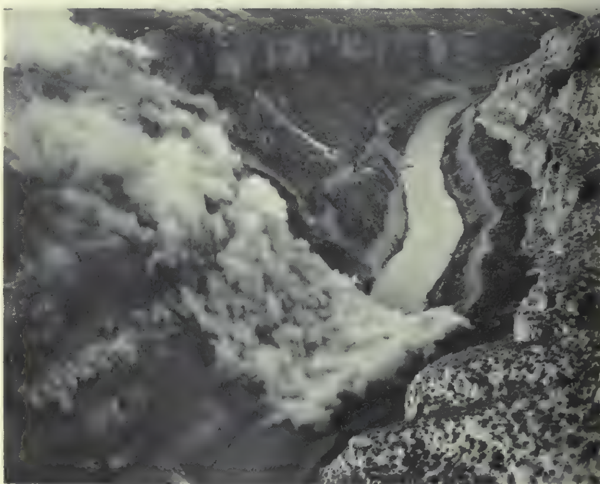


Hoover Dam. The 17th and final generating unit in the Hoover Powerplant—on the Colorado River between Arizona and Nevada—went on the line on November 30, 1961, slightly more than a month after the plant's 25th anniversary (October 26) of commercial power production. The final unit, N–8, increased the plant's nameplate capacity to 1,344,800 kilowatts. Some of the benefits derived from the great multipurpose dam and its appurtenant works during a quarter century include the production of approximately 105 billion kilowatt-hours of hydroelectric energy; the grossing of $202.5 million in revenue; water to produce crops valued at a total of $2.33 billion; flood control; and municipal and industrial water.

Trinity Dam, a multipurpose structure on the Trinity River near Lewiston, Calif., was dedicated in a ceremony on October 14, 1961, sponsored by the Trinity Conservation & Recreation Development Association. The 537-foot-high earth dam was authorized by Congress in 1955 and was topped out in the fall of 1960. It is a major feature of the Bureau of Reclamation's Central Valley project and the world's highest completed earthfill embankment. Trinity Reservoir, which began filling a year ago, will store 2.5 million acre-feet of water, exceeded in size in California only by Shasta Lake above Reclamation's Shasta Dam on the Sacramento River. The Trinity River Division, scheduled to be completed by mid-1964, will increase by nearly 1.5 million acre-feet the irrigation water available to the Central Valley project.

East Bench unit, MRBP. Contracts were awarded last fall for two major dams on the East Bench unit, Three Forks Division, of the Missouri River Basin project in Montana. A groundbreaking ceremony for the unit's principal feature, Clark Canyon Dam on the Beaverhead River near Dillon, was sponsored on October 1 by the Clark Canyon Water Supply Co., the East Bench Irrigation District, and the Beaverhead County Chamber of Commerce. The earth dam will be about 133 feet high and will create a reservoir with a capacity of 261,000 acre-feet of surplus water from Red Rock River and Horse Prairie Creek, tributaries of Beaverhead River. Contract has also been awarded for construction of Barretts diversion dam on the Beaverhead River.

Yellowtail Dam construction on the Big Horn River near Hardin, Mont., was initiated with a groundbreaking ceremony on October 18, 1961. The blast removed more than 1,600 tons of rock. The multipurpose structure, which will rise to a height of 520 feet, will be the largest concrete dam to be built on the Missouri River Basin project. The Yellowtail Unit is scheduled to be completed in 1967 and will provide major irrigation, flood control, and hydroelectric power, as well as fish and wildlife and recreation benefits. Backing up the Big Horn River 70 miles beyond Kane, Wyo., the Yellowtail Reservoir will store 1,375,000 acre-feet of water with a maximum surface area of 27 square miles.



With the Water Users

The manager of the Chelan County (Wash.) Public Utility District was named "State Industrialist for 1961" by the Washington Association of Realtors. Senator Warren G. Magnuson, in presenting the award at a Seattle meeting of the association last fall, reviewed Kirby Billingsley's lifetime of work in the development of north-central Washington, emphasizing his interest in hydroelectric power, reclamation, and industrial development. Mr. Billingsley began his career as a newspaperman on the *Wenatchee Daily World* and had a hand in the paper's work in support of Grand Coulee Dam and the Columbia Basin project. He later joined the State division of progress and industry and then was secretary of the Columbia Basin Commission for several years.

☆ ☆ ☆

A joint committee, under the auspices of the Othello (Wash.) Jaycees and the Soil Conservation Service, named Mike Livingston as Othello's "Conservation Farmer of the Year" the latter part of 1961. Mr. Livingston, who took over a Columbia Basin unit some 2 years ago, has improved the irrigation system in addition to other conservation practices. This has entailed installation of concrete pipelines and concrete-lined ditches, which enables him to make more efficient use of irrigation water. He has done an effective job of weed control and crop rotation and makes good use of crop residues.

BUREAU'S TOP DESIGN TRIO

Left to right are Emil V. Lindseth, Oscar L. Rice, and John Parmakian. Mr. Rice is now Chief Designing Engineer.

Oscar L. Rice is now Chief Designing Engineer of the Bureau of Reclamation, succeeding L. G. Puls who retired last fall.

Mr. Rice is assisted by Emil V. Lindseth, Assistant Chief Designing Engineer (Electrical and Mechanical), and John Parmakian, Assistant Chief Designing Engineer (Civil and Structural).

All three are registered professional engineers and are headquartered in the Office of the Assistant Commissioner and Chief Engineer in Denver.

Mr. Rice is a graduate of Utah State Agricultural College (now University) and has been with the Bureau since 1923. Under his direction is the design of such large dams as Glen Canyon, Ariz.; Flaming Gorge, Utah; and Yellowtail, Mont. He is a member of the International Commission on Large Dams.

Mr. Lindseth is an electrical engineering graduate of Washington State College (now University). He came to the Bureau in 1934. He is a member of the International Conference of Large Electric Systems (CIGRE), the International Commission of Irrigation and Drainage, the International Commission on Large Dams, and the American Institute of Electrical Engineers.

Mr. Parmakian, who began his career with the Bureau in 1930, is a graduate of Massachusetts Institute of Technology and received his master's degree from the University of Colorado. He is a member of the American Society of Civil Engineers and a director of the American Society of Mechanical Engineers.

Mr. Puls, who retired on October 31 after 28 years' service with the Bureau, attained world renown for his design work on such structures as Glen Canyon and Flaming Gorge Dams and on Monticello Dam in California. He has entered private practice as a consulting engineer, and is now on an assignment in India. ###

San Dimas

Continued from page 12

are scooped out by heavy bulldozers on contour intervals of 40 to 90 feet, depending on the steepness of the slope. These terraces, which slope inward, can intercept runoff and halt the movement of debris that would result from a 3-inch rainstorm.

Nine other watersheds have been stabilized by soil cement check dams in the stream channels. Still another test designed to protect steep slopes consists of the hoeing of barley and fertilizer into contour rows of 2-foot vertical intervals.

Each basin under test is equipped with a gaging station to measure inflow to a settling basin. The control is a flume through which moving bedload passes freely. Suspended load is measured in bracket-mounted sediment samplers at several levels.

The effluent is measured by another gaging station with weir control. The volume of coarse material settled out is determined upon removal from the settling basin after each storm. Certain untreated burned areas are equipped with identical measuring devices and used as a basis for comparison.

For the time being at least, San Dimas Experimental Forest is not the showplace for visitors which it was before the fiery ordeal. On this plot of scorched earth, the Forest Service, in cooperation with interested State and local agencies, accepts the challenge of continued leadership in forest watershed management research. ###

Wind Erosion

Continued from page 10

soil subject to wind erosion and under such circumstances provides little or no organic matter or fertility to succeeding crop.

Besides the protective cover provided during late fall, winter, and early spring, the following tabulation gives amount of dry matter and nitrogen which was turned under prior to planting field corn in 1961:

	Dry matter per acre (top growth)	Percent nitrogen	Nitrogen per acre
	Pounds		*Pounds*
Rye	1,660	1.68	28
Vetch	2,620	3.43	90
Rye and vetch	3,080	3.11	96

The most pronounced use of irrigation water is generally on the light-textured soils and is usually associated with long or relatively long runs. In order to demonstrate the effect of variable length of runs on soils having a high infiltration rate, the length of runs on one field planted to corn ranged from 400 to 700 feet. Preliminary results in 1961 indicated from 10 to 20 percent increase in water use for each 100-foot increase in length or rows. This work will be repeated in 1962 under better controlled conditions.

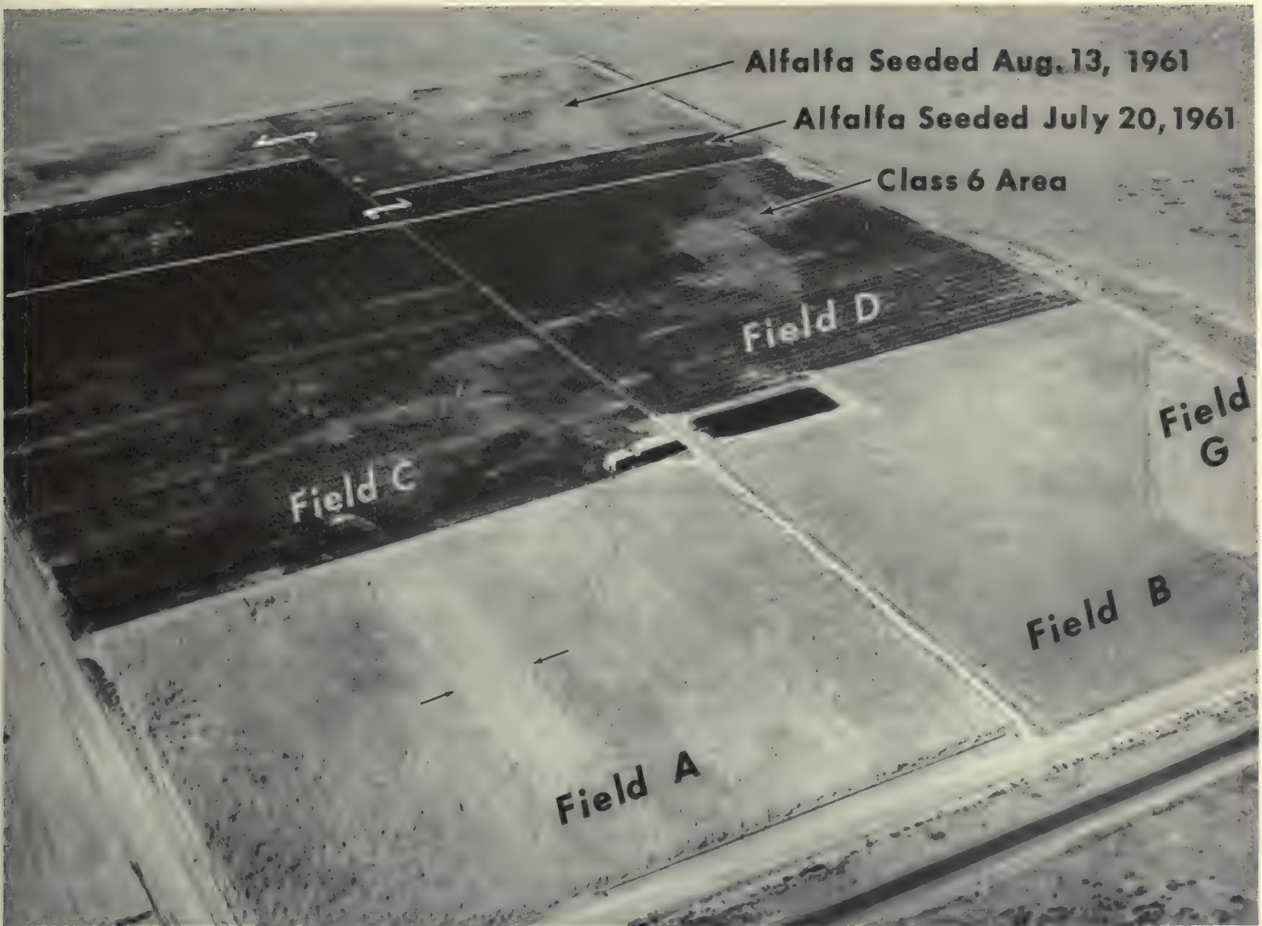
This matter of timing operations in order to obtain sufficient ground cover to insure against wind erosion is sometimes difficult to "sell." Perhaps the basic underlying factor is economics, the pressure of which may make a farmer consider it necessary to get land in production as quickly as possible. Because of variable weather conditions as well as variable soil conditions and because of the need for a cash crop, it is understandable why a slower or slightly delayed but better timed development is not always accepted by the farmers.

The development of light-textured soils under sprinkler irrigation is more flexible in several respects. For instance—

1. Where the soil surface is relatively smooth to permit efficient operation of harvesting equipment and wheel-move sprinkler lines, such crops as alfalfa can be seeded directly into the native cover. Under such conditions, the timing is less restrictive.

2. When it is necessary to disturb surface soil too rough for wheel-move sprinklers and farm

Extra furrow between rows gives additional protection. Larger clods are the result of fibrous roots of rye.



Fields A and B are planted to corn. Light strip through center of A had rye only as cover. Balance of A and all of B had both rye and vetch cover. Field G was undeveloped, resulting in part from variable length irrigation runs in Field B and to test requirements. Field C shows alfalfa seeded in native grass cover. Alfalfa stand on Field D (class 6 area), about 50 percent, was still sufficient to control erosion. Late 1961, July alfalfa seeding had approximately 12-inch growth, compared to 2 inches for August seeding.

machinery operations, the sprinkler system can be installed well ahead of land preparation and the seeding of crops. Thus, the time that the land has to be exposed is greatly reduced as compared to gravity irrigation.

Two dates of seeding alfalfa were made both years. The following conclusions and recommendations can be made:

1. It is possible to secure a good stand of alfalfa by seeding directly into the native cover consisting of native grasses including cheat grass during the summer months without subjecting the soil to any wind erosion.

2. When it is necessary to do some leveling which destroys the cover and soil root structures, it is better to seed during the months of June, July, and early August. Not only does this give more time for plant development before the time of year when an occasional severe wind can be expected, but the alfalfa seedlings develop more rapidly during the days of longer daylight and higher temperatures.

3. Alfalfa seedings made during the middle of August in 1961 on disturbed soil (soil that required leveling to permit the use of wheel-move sprinklers) required the spreading of straw immediately ahead of sprinkler irrigations in order to protect the seedlings. During years of favorable September weather this would not be required.

4. When alfalfa seedings on disturbed soil have to be delayed until August or early September, it is well to seed about 30 pounds of rye or winter cereals per acre at the time the alfalfa is seeded.

5. Winter grains with or without vetch when seeded in moist soil to insure immediate germination during late August or early September should give adequate winter cover crop to protect soil against wind erosion. # # #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5537	Columbia Basin, Wash	Nov. 6	Enlargement of Potholes canal, Sta. 402+00 to 471+00, Schedule 2.	Sine Construction Co. and George W. Lewis, Kennewick, Wash.	$191,400
DC-5640	do	Oct. 5	Completion of Trinity, Clear Creek, and Spring Creek powerplants and Clear Creek switchyard.	E. V. Lane Corp. and Gunther and Shirley Co., Palo Alto, Calif.	2,949,108
DC-5645	Missouri River Basin, Kans.	Nov. 9	Construction of earthwork, structures, and track for relocation of Chicago, Rock Island and Pacific railroad and connections to Chicago, Burlington & Quincy railroad for Norton Dam.	Van Buskirk Construction Co., Sioux City, Iowa.	2,381,602
DS-5647	Central Valley, Calif	Oct. 12	Nine 230-kv power circuit breakers for Tracy switchyard.	Allis-Chalmers Mfg. Co., Denver, Colo.	418,600
DC-5650	Central Valley, Calif	Oct. 9	Construction of earthwork, pipelines, and structures and three reservoirs for El Dorado Main and laterals.	Underground Construction Co., Inc., Oakland, Calif.	1,181,030
DC-5651	Lower Rio Grande Rehabilitation, N.Mex.	Oct. 13	Clearing, and construction of earthwork, concrete lining, and structures for rehabilitation of 6.0 lateral system.	Fitzgerald and Co., Inc., Donna, Tex.	497,104
DC-5654	Colorado River Storage, Utah-Wyo.	Oct. 18	Construction of earthwork, structures, and surfacing for relocation of Wyoming State Highway No. 530.	A & B Construction Co., Helena, Mont.	607,177
DC-5657	Grand Valley, Colo	Oct. 26	Relocation and modification of structures on Highline and Orchard Mesa canals.	Gardner Construction Co., Grand Junction, Colo.	697,368
DC-5665	Missouri River Basin and Seedskadee, Mont.-Wyo.	Nov. 17	Construction of 47 relocatable residences for Yellowtail and Fontenelle dam government communities.	Transa Structures, Inc., Fullerton, Calif.	421,941
DC-5666	Missouri River Basin, Nebr.	Nov. 28	Construction of earthwork and structures for Red Willow canal, Sta. 8+00 to 476+50, and laterals and drains.	Bushman Construction Co., St. Joseph, Mo.	709,357
DC-5667	Central Valley, Calif	Nov. 7	Construction of earthwork, pipelines, structures, and six reservoirs for Diamond Springs main, feeder line, and laterals for El Dorado distribution system.	F. W. Case Corp. and Hood Construction Co., Sacramento, Calif.	1,765,946
DC-5670	do	Nov. 22	Construction of 22 miles of Keswick-Gas Point Road-Cottonwood 230-kv transmission line.	Power City Construction and Equipment Co., Spokane, Wash.	1,158,413
DC-5671	Colorado River Storage, Colo.	Nov. 17	Construction of 39.17 miles of Blue Mesa-Curecanti, Morrow Point-Curecanti, and Curecanti-Montrose 115-kv transmission lines.	Jax Construction Co., Inc., Yazoo City, Miss.	681,565
DS-5672	Colorado River Storage, Colo.-Utah.	Oct. 13	Surveys for 160 miles of Curecanti-Midway 230-kv transmission line. (Negotiated contract.)	F. M. Limbaugh Engineering, Inc., Albuquerque, N. Mex.	340,330
DS-5673	Colorado River Storage, Ariz.	Oct. 9	Surveys for 130 miles of Flagstaff-Pinnacle Peak 345-kv transmission line. (Negotiated contract.)	Desert Sun Engineering Corp., Phoenix, Ariz.	242,800
DS-5674	Colorado River Storage, N.Mex.	Oct. 9	Surveys for 170 miles of Shiprock-Albuquerque 230-kv transmission line. (Negotiated contract.)	Continental Engineers, Inc., Denver, Colo.	184,975
DS-5675	Colorado River Storage, Colo.	Oct. 9	Surveys for 156 miles of Curecanti-Craig 230-kv transmission line. (Negotiated contract.)	Clair A. Hill & Associates, Redding, Calif.	410,360
DC-5680	Missouri River Basin, S. Dak.	Dec. 8	Construction of 88 miles of Rapid City-Newell-Maurine 115-kv transmission line.	Main Electric, Inc. and A. D. Hagenstein, Minot, N. Dak.	938,739
DC-5681	Missouri River Basin, Nebr.	Dec. 6	Construction of Red Willow Creek diversion dam and Red Willow canal and settling basin.	Bushman Construction Co., St. Joseph, Mo.	333,607
DC-5684	Missouri River Basin, S. Dak.	Dec. 15	Designing, furnishing and installing equipment, and construction of Eagle Butte, Martin, Maurine, Mission, and Newell substations.	Marson Construction Co., Inc., Cambridge City, Ind.	1,356,990
DC 5686	Klamath, Oreg.-Calif	Dec. 6	Construction of earthwork and structures for laterals and drains, Sump 3, Contract Unit 3.	John M. Keltch, Inc., Pasco, Wash.	274,322
DC-5687	Central Valley, Calif	Dec. 18	Construction of Red Bluff diversion dam	Vinnell Corp., Alhambra, Calif	3,465,155
DC-5690	Columbia Basin, Wash	Nov. 24	Enlargement of Potholes canal, Sta. 23+00 to 166+73 and 471+00 to 510+00.	Floyd Williams, Inc., Kennewick, Wash.	228,450
DS-5685	Central Valley, Calif	Dec. 28	One generator-voltage bus structure, two 600-volt feeder busways, and two metal-clad switchgear assemblies for Spring Creek powerplant.	Westinghouse Electric Corp., Denver, Colo.	270,831
DC-5694	Columbia Basin, Wash	Dec. 29	Construction of additions to White Bluffs pumping plant No. 2 and construction of switchyard and WB10 discharge line.	George A. Grant, Inc., Richland, Wash.	203,014
DC-5698	do	Dec. 22	Construction of earthwork and structures for Block 23 laterals and wasteways, Wahluke Branch canal laterals.	R. A. Heintz Construction Co., Portland, Oreg.	1,055,223
DC-5702	Missouri River Basin, S. Dak.	Dec. 29	Construction of 75 miles of Oahe-Eagle Butte 115-kv transmission line.	Malcolm W. Larson Contracting Co., Denver, Colo.	787,687
400C-174	Provo River, Utah	Dec. 28	Construction of earthwork and structures for Woodland bridge dike extension and Fitzgerald dike for Provo River Channel revision.	Ford Construction Co., Inc., Provo, Utah.	288,415

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Major Construction and Materials for Which Bids Will Be Requested Through February 1962*

Project	Description of Work or Material
Avondale, Dalton Gardens, and Hayden Lake Distribution Systems, Idaho.	Removing existing corroded distribution lines and valves and furnishing and installing about 29.9 miles of replacement piping and reinstalling valves. Eight miles north of Coeur d'Alene.
Canadian River, Tex.	Constructing Sanford Dam, a 14,900,000-cu-yd earthfill structure, 200 ft high and 6,410 ft long, with a morning glory spillway, a flood control outlet works, and a river outlet works tunnel. On the Canadian River, about 40 miles northeast of Amarillo.
Chief Joseph Dam, Wash.	Constructing about 6.8 miles of from 4- to 20-in.-diameter Howard Flat pipe laterals for heads of from 150 to 450 ft, one concrete-lined reservoir, 120 by 150 ft, and 7 ft deep, and three pumping plants of 15.9, 5.5, and 1.0 cfs capacities. Near Chelan.
CRSP, Ariz.	Completion work for the Glen Canyon Powerplant will consist of placing concrete for turbine embedment and generator support, installing eight 155,500-hp, 150-rpm, vertical-shaft, hydraulic turbines, transformer bank, and other mechanical and electrical equipment, constructing interior masonry wall partitions, applying architectural finishes and installing architectural features. Completion work for the switchyard will consist of extending existing graded area, placing concrete lining in control cable tunnel, constructing concrete foundations, furnishing and erecting switchyard and transformer circuit steel structures, installing six 345-kv, seven 230-kv, four 138-kv, and six 15-kv circuitbreakers, four 345/230-kv and four 230/138-kv transformers, one 138-kv and one 15-kv regulating transformers and associated electrical equipment, major items of which will be Government furnished. At Page.
CRSP, Colo.	Constructing Blue Mesa Dam, a 3,000,000-cu-yd earthfill structure, 340 ft high and 800 ft long, with a 16-ft-diameter outlet tunnel, a 21-ft-diameter spillway tunnel, and a 60,000-kw powerplant. Work will also include constructing 1.3 miles of powerplant service road, and relocating 5.3 miles of State Highway No. 92. On the Gunnison River, about 25 miles downstream from Gunnison.
Do.	Furnishing and installing fence gates, clearing right-of-way, constructing concrete footings, furnishing and erecting steel towers, and furnishing and stringing ACSR and steel overhead ground wires for about 174 miles of 230-kv, single-circuit Curecanti-Craig Transmission Line. From a point about 3 miles east of Montrose, to a point near Craig.
Do.	Furnishing and installing fence gates, clearing right-of-way, constructing concrete footings, furnishing and erecting steel towers, and furnishing and stringing ACSR and steel overhead ground wires for 114 miles of 230-kv, single-circuit transmission line (Cortez-Curecanti Section). Work will also consist of furnishing and stringing ACSR and steel overhead ground wires for 42 miles of 230-kv, single-circuit transmission line (Shiprock-Cortez Section). From Cortez, to a point about 3 miles east of Montrose.
CRSP, N. Mex.	Ballasting and track laying for about 11.5 miles of Denver and Rio Grande Western Railroad narrow gage line around the reservoir to be created by Navajo Dam. About 45 miles southeast of Durango.
CRSP, Utah	Constructing about 122 miles of wood-pole, H-frame, 138-kv transmission line (Vernal-Springville), complete with three 477 MCM, 24/7, ACSR, and two 3/8-in. steel overhead ground wires. From Vernal to Springville.
Columbia Basin, Wash.	Constructing the Moses Lake control works will consist of a reinforced concrete, stoplog, controlled check structure with five 10-ft-wide bays to control water surface elevations between Moses Lake and Potholes Reservoir.
Do.	Concrete lining from Station 0+00 to Station 114+82 in the W44A lateral, south of George.
Florida, Colo.	Constructing the Florida Farmers Diversion Dam; constructing about 3.6 miles of the Florida Farmers Ditch enlargement, 1.2 miles of which will be earthlined; and constructing about 1.7 miles of the Florida Canal enlargement, and appurtenant structures. Near Durango.
MRBP, Kans.	Earthwork and structures for about 7.5 miles of canal with bottom widths varying from 12 to 5 ft and about 24 miles of laterals with bottom widths varying from 6 to 3 ft, including about 0.4 mile of earthlined lateral. Cedar Bluff canal and laterals, near Ellis.
MRBP, Mont.	Earthwork and structures for about 9.1 miles of unlined canal and about 4.6 miles of asphalt-membrane-lined canal with bottom widths varying from 20 to 16 ft, and constructing about 16.9 miles of unlined laterals and about 8.2 miles of asphalt-membrane-lined laterals with bottom widths varying from 10 to 3 ft, and appurtenant structures. East Bench canal and laterals, near Dillon.
Do.	Furnishing and installing fence gates, clearing right-of-way, constructing concrete footings, and furnishing and erecting steel towers for about 160 miles of 230-kv, single-circuit Dawson County-Custer Section (Yellowtail-Dawson County) Transmission Line.
MRBP, S. Dak.	Constructing about 65 miles of wood-pole, H-frame, 115-kv Eagle Butte-Maurine Transmission Line complete with three 477 MCM, 24/7, ACSR, and two 3/8-in. steel overhead ground wires. From Eagle Butte to Maurine.
Smith Fork, Colo.	Clearing trees, shrubs, fences, and a few buildings from about 375 acres of the Crawford Reservoir site, south of Crawford.
Vale, Oreg.	Constructing Bully Creek Dam, a 1,000,000-cu-yd earthfill structure, 104 ft high and 3,080 ft long, and appurtenant structures. On Bully Creek, about 9 miles west of Vale.
Weber Basin, Utah	Earthwork and structures for about 15 miles of earthlined Layton Canal, near Ogden.
Do.	Constructing Causey Dam, a 1,230,000-cu-yd earthfill structure, 197 ft high and 730 ft long, and appurtenant works, including a concrete spillway and a tunnel outlet works. On the South Fork of the Ogden River, about 18 miles east of Ogden.
Do.	Completing Willard Dam adding 3,800,000 cu yd of earthfill to the existing embankment. This additional fill will raise the height of the structure to 34 ft and will extend the crest length to 75,000 ft. At Willard Bay, 11 miles northwest of Ogden.
Do.	Enlarging about 9 miles of canal from an 8- to a 30-ft bottom width, constructing about 2 miles of new canal with a 30-ft bottom width, constructing appurtenant structures, and earth lining the entire length. Willard Canal, near Ogden.
Wichita, Kans.	Constructing Cheney Dam, a 7,700,000-cu-yd earthfill structure, 86 ft high and 24,500 ft long, and appurtenant structures, including concrete conduit spillway, river outlet works, and municipal water supply outlet works.

* Subject to change.

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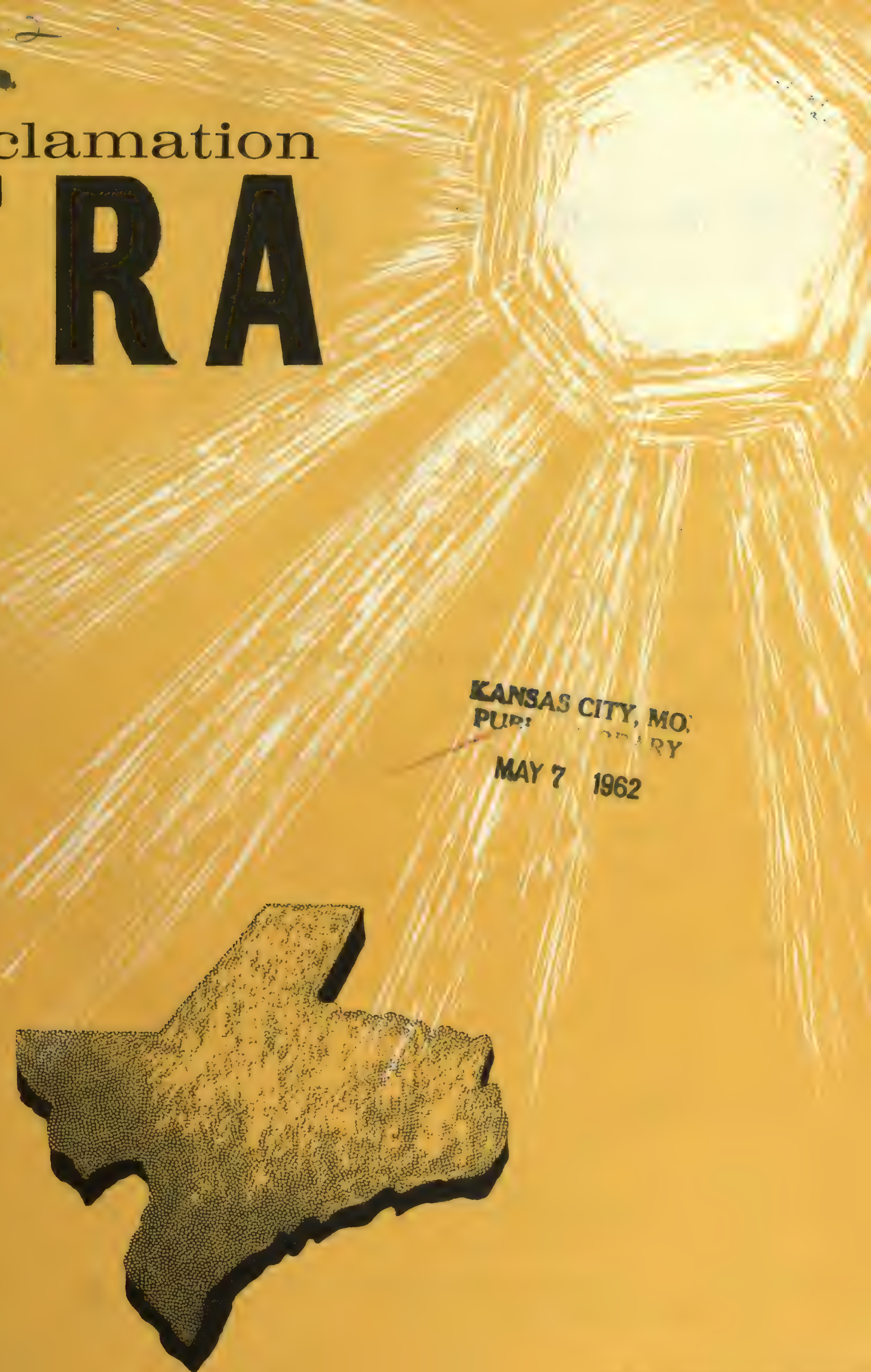
What's Coming:

Something New Under the Texas Sun

Land Appraisal Policy

Reclamation ERA



MAY 1962

The Reclamation Era

MAY 1962 VOLUME 48, NO. 2

In this issue . . .

VIOLET PALMER, Editor
KATHRYNE DIMMITT, Art Editor

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Something New Under the Texas Sun

by HARRY P. BURLEIGH [1]

Texas, like other Western States, faces a multiplicity of water problems.

Flooding is not uncommon. Pollution is becoming increasingly complex. Fish and wildlife and recreation opportunities inherent in water development have been only partially exploited. A major share of the State's irrigation is dependent upon depleting ground water reservoirs.

But the basic Texas water problem remains the geographical imbalance of water supply and water needs. River basins in the eastern portion of the State yield water supplies in excess of predictable requirements; the basins generally west of the 97th meridian cannot develop water supplies in sufficient quantities to meet requirements.

In the past, the State has been largely agrarian. The last 2 decades, however, have witnessed a significant shift in population from rural to urban, accompanying a major change in the Texas economy which is now primarily industrial. As a result, the past decade has seen industrial and municipal water requirements mount astronomically.

The necessity for a comprehensive study of the Texas water situation brought about a unique experiment in government—the United States Study Commission for Texas, which was created by Public Law 85–843, 85th Congress.

Establishment of the Study Commission was the result of a desire by Vice President Lyndon B. Johnson (then senior Senator from Texas) and other Members of the Texas congressional delegation to have a coordinated plan for Texas water development to guide Congress in considering future authorizations and appropriations for Federal water projects in Texas.

At the time the Study Commission was created, Congress had appropriated or considered appropriation of close to $1 billion for Texas water development in the absence of a comprehensive statewide plan of any sort.

Although created by Federal legislation, the USSC-Texas includes representation from three echelons of government: Federal, State level, and sub-State level. Sixteen Commission members were appointed: Six from the Federal agencies (Departments of the Interior, Army, Agriculture, Commerce, and Health, Education, and Welfare, and the Federal Power Commission); one was appointed by the Governor of Texas to speak for interests of the State as a whole; and the remaining members were appointed from the various river authorities that have been designated by the Texas Legislature to develop inbasin water supply and control plans. Overall, 10 of the Commissioners represented State level or sub-State level interests; 6 of the Commissioners represented Federal level interests.

George R. Brown of a Houston engineering firm was Commission chairman.

Directives given the Commission in its legislation were broad. By its own action, the Commission recognized water supply and control as the basic Texas water problem and restricted its purpose to the formulation of a plan for these purposes. The decision recognized that as component projects of its overall plan evolved, allied multipurpose features could be integrated into those projects.

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[1] Mr. Burleigh, area engineer in the Bureau of Reclamation's Austin (Texas) Development Office, represented the Department of the Interior on the United States Study Commission for Texas.

The Commission held its first meeting at its Houston, Tex., headquarters on January 5, 1959, and its last meeting on January 22, 1962. In the intervening period, it met 28 times. At its second meeting, the Commission determined to create its plan through the mechanics of:

1. Assembly of a small professional staff, and

2. Utilization of data currently available from the agencies represented on the Commission and other agencies.

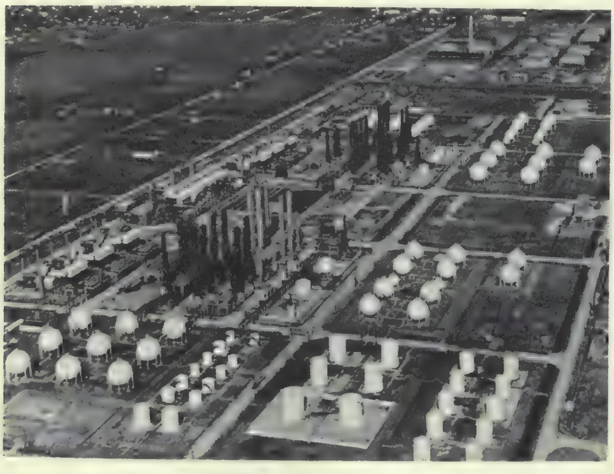
The aggregate mass of data from the separate sources was tremendous. The basic function of the Commission staff was organization of it into a usable form as a basis for a water supply and control plan.

The USSC recognized that professional findings, however acceptable in a professional world, might not be accepted at the water-user level. It, therefore, took to the water-using public certain findings of a controversial nature. Specifically, the water-using public was asked to constructively comment upon Commission findings with respect to predicted water requirements over the forthcoming half century, area by area.

The Commission completed its work in January 1962. Its report was to go to the President in March of this year and thereafter to the Congress. Ninety days after receipt of the report by the President, the Commission ceases to exist as a Federal entity.

Because the Study Commission represented virtually the total spectrum of Texas water interests and because it was a new experiment in government, it faced many problems. Parochial opinion as to water requirements had to be rationalized.

This segment of the petrochemical complex in Texas symbolizes the change in the economy from primarily agricultural to industrial.



Divergence in program aims of a variety of water agencies had to be oriented to a common goal; an incredible mass of physical data from a variety of sources had to be gathered, organized, and evaluated.

Furthermore, Texans have become acutely aware of the present and future values of water. They know that water in Texas, as in other areas, is no longer a limitless resource, that its uses must be carefully planned and the available supplies husbanded in an orderly manner.

There was much "give and take" in Commission meetings and it helped clarify the problems and brought better understanding among those who held varied viewpoints.

The Commission accomplished some, but not all, of its objectives. Its basic accomplishments were remarkable.

Among these:

1. It established for eight Texas river basins "inbasin" plans for control and use of basin water that have been accepted and endorsed by the respective basins and the State.

2. It established to the satisfaction of everyone the quantities of water in the separate basins that can be developed for definite beneficial purposes.

3. It established good estimates of future water requirements (municipal and industrial and agricultural), with due consideration for the broad mass of opinion from the public, whose endorsement would be required.

4. It laid the broad framework for a true "areawide" plan for the State that involves transport of tremendous quantities of water from areas of surplus to areas of demonstrable deficiencies.

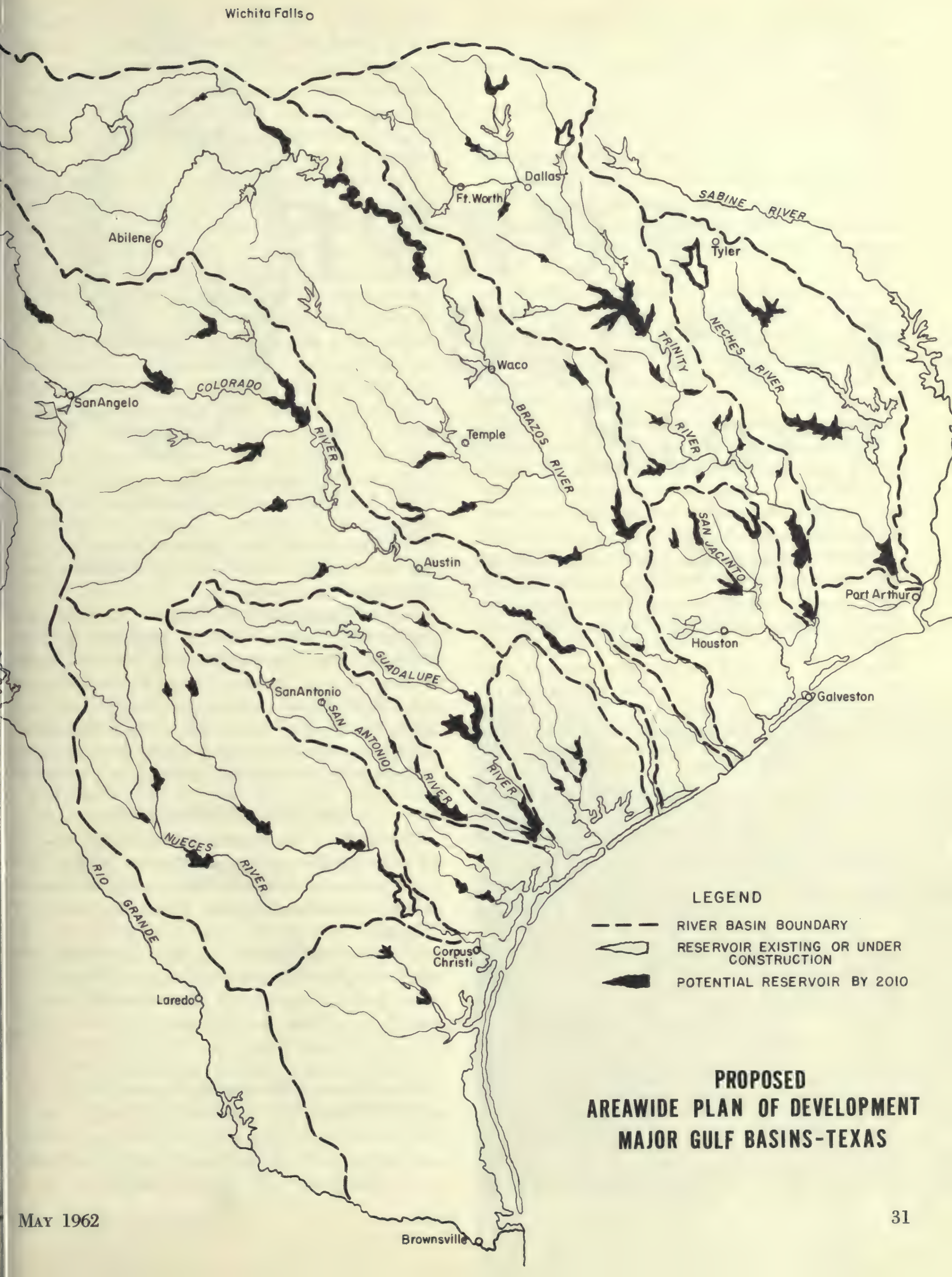
5. It established the cost of the dams and reservoirs and water conveyance works that would be required to meet future requirements.

Perhaps the basic accomplishment of the Commission was establishment, for the satisfaction of the Texan in general, of the fact that water supply in Texas within the foreseeable future is not an issue, that the real problem is construction of works for *development* of available waters and *delivery* to the points of need.

Commission recommendations for water use and control plans include:

1. Ultimate construction of 83 multipurpose and single-purpose dams at a total cost of $1.6 billion.

2. Water conveyance works (intra and interbasin), as needed, at an estimated cost of $983 million.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Houston
GUADALUPE RIVER
SanAntonio
SAN ANTONIO RIVER
Galveston
NUECES RIVER
RIO GRANDE
Corpus Christi
Laredo
Brownsville
LEGEND
RIVER BASIN BOUNDARY
RESERVOIR EXISTING OR UNDER CONSTRUCTION
POTENTIAL RESERVOIR BY 2010
PROPOSED
AREAWIDE PLAN OF DEVELOPMENT
MAJOR GULF BASINS-TEXAS

3. Upstream land treatment programs at an estimated cost of $187 million.

4. Modest proposals relevant to hydropower, navigation, and drainage.

The Commission divided its proposals into two phases:

1. A series of projects that it concludes must be in operation by 1975; total cost $525 million.

2. An overall plan required by the year 2010 with a total cost for all required works of approximately $4 billion, including cost of the "phase" to 1975.

The Commission did not satisfy all of the directives contained in its basic legislation. It did not provide an economic evaluation of the works it proposed for construction. Lacking this, it did not tell either Texas or the United States what the economic impact of the development and control of Texas water would be to Texas and the Nation.

The Commission did not apportion responsibility for the construction of the proposed works: First, as between State and Federal interest; second, for the Federal effort among the Federal construction agencies.

The preceding omissions will not materially detract from the overall Commission achievement. The agencies concerned may now pursue their separate programs under their own policies and procedures in the broad framework of a preconceived water use and control plan that has been generally endorsed by their own representatives participating in the Commission planning.

Houston is one of the busy Texas cities needing increased domestic and industrial water. Although 50 miles inland, it is a major seaport, thanks to its ship channel, part of which is shown here.

The broad proposals advanced by the Commission came from day-to-day, week-by-week, month-to-month interchange of ideas among hydrologists and engineers, well irrigators and surface water irrigators, city water superintendents and the river authority heads, and others.

The overall Commission proposals and plans represent a consensus and a rationalization of views of everyone concerned; i.e., the water user who buys and pays for the water and the technician who plans for its development.

As a result of the Commission effort the coordination in Texas between the Federal agencies has become most effective. State level interests and the public at large have acquired an awareness of the techniques and skills that are available in both the Federal and State level agencies as aids to meet both local and statewide water problems. The coordination and interagency cooperation generated by the Study Commission effort will continue.

The final results of the Commission, as an experiment of government, are yet to be observed. It is impossible to pass judgment on the Commission as an instrument of public policy until a number of years have passed.

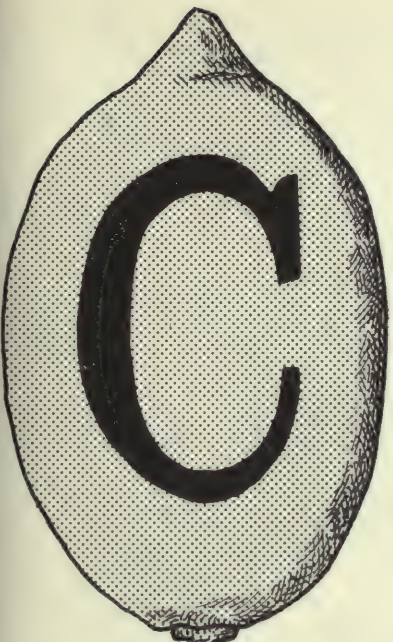
Several decades will be required to determine how effectively Commission proposals will be translated into operating projects. In view of the wholesome interchange of ideas, the interchange and acceptance of a variety of viewpoints by the various echelons of government, it is a reasonable assumption that the Study Commission was worth the investment in time and money. # # #

HUGH BUTLER LAKE

The lake to be formed behind a Bureau of Reclamation dam under construction on Red Willow Creek, near McCook, Nebr., will be named in honor of the late Senator Hugh A. Butler of Nebraska.

The reservoir will have a capacity of approximately 88,000 acre-feet with the larger part devoted to flood control and the remainder providing opportunities for irrigation and recreation, affecting a three-State area. Construction of the dam and reservoir was initiated July 4, 1960.

At the time of his death, Senator Butler, who served Nebraska in the Senate for nearly 14 years, was chairman of the Senate Committee on Interior and Insular Affairs, and was a strong proponent of reclamation and flood control. # # #



Citrus Success Story

by JONES OSBORN, Editor and Publisher,
The Yuma Daily Sun

The year 1961 made news of many kinds in our farm community in southwestern Arizona, and not the least important was the story of unusual success in our mushrooming citrus groves. Our lemon growers, in particular, can look back on one of the most prosperous seasons since the start of a new planting boom 8 years ago.

Lemons are but one of our citrus products. On warm, nearly frost-free Yuma Mesa we also grow oranges, grapefruit, and small blocks of limes, tangerines, tangelos and rare orange varieties.

But lemon growers stole the headlines during the past winter. Even after they had paid costs of harvesting, packing, marketing and promotion, they received 1.6 cents on each pound of fruit. It brought lemon growers nearly $1 million.

This reward is but one of the amazing sides to an astonishing reclamation development. At the close of World War II, the area surrounding the Air Force base, 4 miles south of Yuma, was nothing but barren desert.

Then Congress in 1947 enacted the Gila Project Reauthorization Act, and President Truman signed it into law in July of that year. That act authorized the bringing of Colorado River water to 115,000 acres of land in the Yuma area, in-

Freshly picked grapefruit is loaded into truck. It will soon be on way to Nation's dining tables.

Heavy tangerine yield on these Yuma Mesa trees necessitated use of interior support for limbs. (Photo by *Yuma County Farmer*.)

cluding 25,000 sun-drenched acres on the Yuma Mesa.

The Yuma Mesa area was first regarded almost wholly as alfalfa cropland. But there were already in production on the adjacent Yuma Auxiliary project about 2,000 acres of grapefruit, some trees as old as 30 years.

This demonstrated success, plus Yuma's warm winters and the arrival of water, invited ventures into costly citrus groves. In just 8 years, citrus acreage has doubled itself three times. We now have 16,500 acres with plans for planting an additional 2,000 acres in 1962.

In a period of 5 years, citrus men planted 4,700 acres of lemons alone. Then the trend turned to Valencia oranges and growers put in 6,000 acres in a 4-year span. That plunge, incidentally, came after the freeze which hit the Florida orange crop in 1957. That winter, dozens of growers readily saw that the Yuma Mesa, which had only one frost all season, was a safer place for their orange orchards.

Costly? Yes. Even with our cheap water and the absolute minimum of frost protection, it costs $2,000 or more per acre to get trees into full production. For groves already planted, this adds up to a $30-million investment. But these same groves, after they all reach maturity, will produce 7,000 railroad cars of citrus a year—a total of nearly seven million cartons of fruit to be packed and shipped.

The citrus boom has brought allied industry along with it. To handle the bounteous crops, packers have spent $3 million on four new packing houses in 4 years. And still they have trouble keeping up with the growers. All of the major citrus organizations are now operating in Yuma.

Yuma's citrus business is a winter business. Lemon harvest starts in September, grapefruit harvest in November, and orange harvest in February.

Most of the maintenance work, too, is done in the winter. The minimal danger of frost damage is offset with wind machines. These are merely big motor-driven propellers mounted on towers to circulate air on chilly nights.

A search for new citrus acreage is underway. Trees are being planted in the Wellton-Mohawk division of the Gila project, 30 miles east of Yuma. Test plantings have been made at Dateland, 65 miles east, and still more at a site 50 miles north of Dateland.

Yuma nurseries grow the trees and do management work for all these plantings. One firm claims the title of "world's largest citrus nursery."

Reclamation, by bringing water to desert land, has proven itself once again. # # #

Almost as far as eye can reach, new, yearling, and fully matured groves of citrus on the Yuma Mesa. (Photo by *The Yuma Daily Sun*.)

BATTLING the mosquitoes

To a mosquito, emergent water weeds rate as home and hearth—or at least as nursery. So do poorly drained fields.

Emergent vegetation in ponds and waterways protect the mosquito's offspring from two natural enemies—wave action and predators such as fish and certain aquatic insects. Although mosquito larvae spend all their time in the water, they are air breathers, and wave action drowns them. Since weeds tend to hinder both wave action and predators, a weed-free environment is of prime importance in prevention of mosquitoes in impoundments.

Poorly drained fields provide favorable breeding places for mosquitoes, and, to discourage them, the solution is better drainage and better management in applying irrigation water.

In areas where other methods of control are not sufficient alone, chemicals, used on a recurrent basis, are necessary to kill the mosquito larvae. Every situation calls for its own combination of methods.

The Bureau of Reclamation has joined with other Federal agencies in seeking a solution to the mosquito problem. Recently a Subcommittee on Vector Control was set up by the Inter-Agency Committee on Water Resources, and consists of representatives from the Army, Tennessee Valley Authority, and Departments of the Interior, Agriculture, and Health, Education, and Welfare. Dr. Stanton J. Ware, of the Division of Irrigation and Land Use in the Bureau's Washington office represents Interior.

Two task groups have been established within the subcommittee—one on preparation of a bulletin on Mosquito Prevention on Irrigated Farms and one on Cooperative Research Studies. To date, seven cooperative studies have been initiated in Western States. It is too early yet to assess the results.

In various parts of the West, the Bureau of Reclamation is cooperating with local mosquito control boards or districts in meeting this problem, not only where project works are concerned but in the surrounding areas.

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In the Milk River Valley

The Milk River project in north-central Montana, comprising a greater part of the Milk River Valley, has an acute mosquito problem due to several existing conditions which provide an ideal situation for propagation of the insects.

A major portion of the valley is characterized by heavy clay soils lying in large acreages, having little gradient. Under the original established practice most of these lands produced native hay, receiving irrigations by flooding from the numerous meandering tributary creeks during times of adequate runoff.

Due to the low intake rate of the soils, the flood waters were held on the meadows for periods extending up to 3 weeks in the belief that additional penetration would result. The project management, in cooperation with interested agencies, endeavored for many years to discourage this practice as a means of securing development and proper irrigation of the lands.

The Bureau of Reclamation, Montana State College Extension Service, and the irrigation districts joined in conducting studies directed toward improved irrigation and cropping practices which demonstrated that crop returns could be greatly increased and mosquito production reduced if the lands were properly handled.

Subsequently, in June 1952, the Montana State Board of Health, the Montana Agricultural Experiment Station, the Agricultural Research Service of the U.S Department of Agriculture, and the U.S. Public Health Service initiated a cooperative program of mosquito investigations in the project area. The studies conducted under this program again clearly demonstrated that proper irrigation and cropping practices would result in greater crop yields and minimum mosquito production.

Contrary to popular belief, the studies showed that a major percentage of the mosquito population was produced on the irrigated fields, rather than in the stagnant water impoundments of sloughs, drains, or slow-moving streams.

As indicated by the studies, proper surface drainage was required to provide for removal of excess irrigation water rapidly, thus limiting mosquito production. The demonstrations were effective in educating many of the water users in methods of mosquito control.

For several years, the irrigation districts have carried on extensive surface drainage programs to provide outlets for excess water. These programs, together with increased land development and improved irrigation methods, have resulted in a reduction of mosquito breeding places. Continued development will ultimately result in discontinuance of the old system of flooding the lands, and further reduction of the mosquito population can be anticipated.

Early in 1961, a group of citizens in the Malta area, determined to promote more effective public education, conducted a series of meetings throughout a proposed mosquito control district. Through the efforts of this group, a Phillips County Mosquito Control District was organized under the provisions of Montana law.

In August, a $7,000 first-year mosquito abatement budget was set up by a three-man board. The budget allotted $1,800 for an entomological survey, $2,500 for larvicide and spray materials, $500 for purchase of equipment for applying larvicide, $500 for renting equipment for draining and filling, $1,000 for wages, $500 for mileage and per diem and $200 for administration. Funds for the mosquito control program are derived from a 5-mill county tax levy.

In California

Local mosquito abatement districts are important on the west coast, and on the Central Valley project the Bureau of Reclamation has cooperative contracts with a number of them.

Bureau of Reclamation cooperative mosquito abatement was established in an agreement with the California State Department of Public Health, March 1951, and in a memorandum of understanding with the U.S. Public Health Service at Washington, D.C., March 1950.

In the Bureau's first conference with State officials, methods of establishing effective mosquito control were discussed. As a start, the Bureau agreed to provide mosquito control on its own right of way.

Both parties realized that relatively little mosquito control would be accomplished on this right of way, surrounded as it is by vast areas under no control, but it was reasoned that the Bureau would set a good example for others to follow. Subsequent events have proved this correct. Irrigation districts and other agencies followed the Bureau's lead, and the cause of mosquito abatement benefited.

Repetitive mosquito control, such as larvicidal spraying, is done by local mosquito abatement districts under cooperative contract with the Bureau.

Elimination of mosquito breeding sources is accomplished in initial construction, if practicable. If not, it is done by Bureau operating personnel or by special contract with a mosquito abatement district. Such work consists of surface drainage, construction of residual drains, and elimination of pockets of stagnant water along canals and around perimeters of reservoirs.

Generally, any program of mosquito abatement conforms with recommendations in reports prepared for the Bureau without charge by the State Department of Public Health. The State even audits charges for cooperative work by local abatement districts and inspects their work for technical adequacy. Such an arrangement is cost saving in that it precludes the necessity of maintaining a staff of Bureau employees technically qualified to do the work.

Cooperative Field Investigations

In Utah, an onslaught on mosquitoes is part of the battle plan of Interagency Task Force Project V, on which the Bureau of Reclamation has a representative. The cooperative research project has been assigned the responsibility of "development of multipurpose management techniques for sewage effluent and irrigation runoff in the Weber basin." Project V is only in the initial stage of its research program; however, investigations are expected to get under way rapidly.

Among some of the things tentatively scheduled for study are (1) the effects of physical modification of shorelines and improved water level management schedules upon production of mosquitoes and the growth and utilization of waterfowl food plants; (2) the effects of drainage and improved soil and water management practices upon mosquito production and crop yields; and (3) evaluation of the effectiveness of a new sewage treatment plant in reducing production of mosquitoes.

Members of the task force are Dr. Don M. Rees, University of Utah, project leader; Dr. Jessop B. Lowe, Utah Cooperative Wildlife Research, Utah State University; Harold Crane, Utah State Fish and Game; Wayne Criddle, Utah state engineer; Lynn Thatcher, Utah State Health Department; Dr. A. D. Hess and James V. Smith, U.S. Public Health Service; Dr. Lyman Willardson, Agricultural Research Service; and Francis M. Warnick, Bureau of Reclamation. # # #

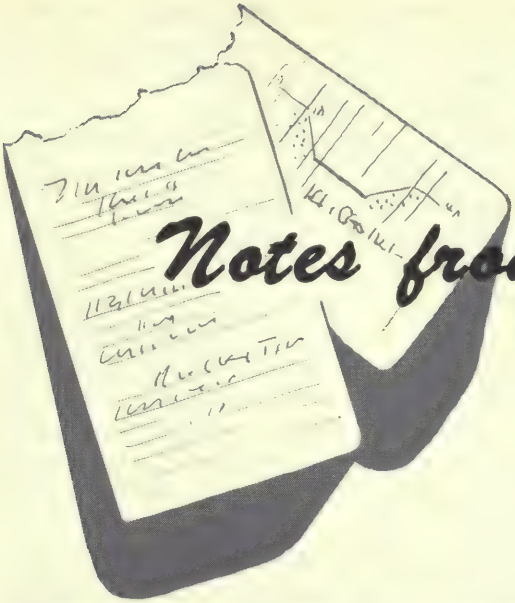
SNACKATERIA at Hoover Dam

Visitors to Hoover Dam like the new look which Nevada blind have given this pioneer Reclamation multipurpose water resource development on the Colorado River.

The Snackateria, constructed in 1960 by the Nevada Welfare Department's Bureau of Services to the Blind, is Hoover Dam's first and only food and refreshment stand. Set against the canyon wall on the Nevada end of the dam, this new modern building has become a popular feature of the world-famous project.

The Snackateria is visited by thousands of people who cross the dam every year. James Ellis of Boulder City, Nevada, who is blind, and his family, operate the concession.

The blind have exclusive rights to operate the food concession at Hoover Dam under the Randolph-Sheppard Vending Stand Act. The Act directs that preference be given to blind persons in operation of vending stands and machines on any Federal property. # # #



Notes from Irrigation Operators' Workshop

Part II

Three specialists discussed efficient operation and maintenance of equipment at the Irrigation Operators' Workshop held in Denver the week of December 11–15, 1961.

They were Paul L. House, Manager, Owyhee Project, North Board of Control, Nyssa, Oregon, who discussed equipment management and costs; and two Bureau of Reclamation engineers, Wesley W. Beck, Head, Pumping Plant Design Group, Division of Design, Denver, and Lyle H. McIntosh, Equipment Specialist, South Platte River Projects Office, Loveland Colorado, who, respectively, discussed mechanical and electrical aspects of pump operation and maintenance.

The highlights of the discussions of these three experts before the 82 Workshop participants from the 11 northern states of the Reclamation West are briefly summarized here.

Although operation of an equipment maintenance and repair shop may be an unnecessary added expense on smaller projects, it is essential on larger projects. Work in a project shop should be scheduled on a regular basis. Lubrication and oil changes at intervals of about 1,000 miles is one of the best preventive maintenance practices for vehicles.

Equipment operating under heavy duty conditions may require servicing more frequently. Through proper lubrication at regular intervals it is possible to nearly double the number of miles

Maintenance of pumps is essential to efficient management of irrigation system served by this pumping plant. Overflow pipe is at left of six pumps; control cubical and moss screen, to right. Pumps should be inspected daily.

of service from equipment without major repairs or overhauls.

Availability of repair parts in the project shop must be considered. If a good parts house is available locally, it may be more expeditious and economical to depend on it rather than attempt to stock parts in the project warehouse. This obviates the necessity of finding an outlet for parts which are obsolescent. Of course, there are some tractor and dragline parts which may be advantageous to stock.

It has been found that after 4 or 5 years, or 50,000 to 60,000 miles, the cost of operation of motor vehicles increases sharply. It may, therefore, be desirable to replace such vehicles when estimated maintenance costs indicate a substantial increase in operating cost.

The cost of maintaining heavier equipment will usually increase during the third or fourth year of operation when tractor rails or other expensive parts may have to be replaced. Major overhauls of such equipment result in a sharp increase of costs but are usually followed by several years of economical operation.

Adequate cost reports are important in evaluating when equipment should be overhauled or replaced. To obtain the necessary information, field report forms of the various items required in equipment operation and maintenance must be completed and be available.

These forms may include breakdowns of costs of fuels and oils, maintenance labor, repair parts and supplies, and hours of use or miles traveled. It may be advantageous to have the warehouse man combine these field reports on one equipment record sheet.

Because of the wide variation in types, sizes, parts, and design of irrigation pumps, manufacturers' instruction books should be carefully read and understood before an attempt is made to start, operate, or service a pumping unit. Daily inspection of pumps should be made by the operator, the ditch rider, or water master. Lubricant, bearing temperatures, and any change in sound or vibration of the pumping units should be noted.

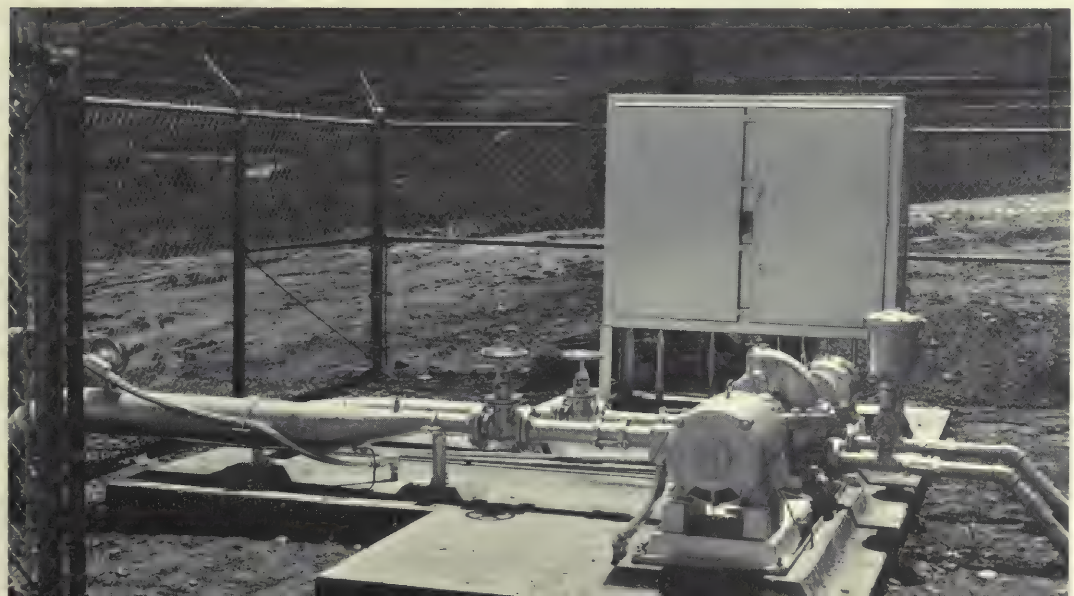
After about 1,000 hours of operation of an irrigation pumping plant or 6 weeks of continuous pumping, an inspection should be made of the stuffing box and drive alinement. Oil-lubricated bearings should be drained and refilled, and grease-lubricated bearings should be examined for the correct amount of grease.

A thorough inspection of each pumping unit should be made once a year by an experienced mechanic and crew. The bearings should be removed, cleaned, and examined for wear. The bearing housings should be cleaned and the stuffing box packing removed and examined for wear.

The coupling halves should be disconnected and the alinement checked. Drains, seal water piping, and any other piping should be flushed. Instruments and measuring devices should be tested for correct operation and accuracy.

Water passages of pump casings should be thoroughly cleaned and painted as required during a complete overhaul. New gaskets should always be available in assembling a pump casing, as the old ones can rarely be salvaged.

Well planned preventive maintenance program, carried out during off-season periods, can eliminate a large portion of breakdown outages common to most pump motors and electrical systems. This is a 2-unit booster pumping plant.



An impeller removed from a pump should be carefully inspected on all surfaces for any unusual wear. The presence of foreign matter in the impeller or casing can cause serious trouble and should be prevented by using suitable protective screens or racks. A cracked impeller usually cannot be successfully repaired and therefore should be replaced. The impeller balance should be checked each time it is out of the casing during an overhaul.

On vertical pumps, misalinement or improper lubricant can cause extensive shaft wear, making replacement necessary. During a pump overhaul the shaft and shaft sleeves should always be examined carefully for any sign of wear or surface irregularities, especially at all the important points of fit.

A well planned preventive maintenance program, carried out during off-season periods, can eliminate a large portion of breakdown outages common to most pump motors and electrical systems. Preventive maintenance at regular intervals involves only the work and repairs indicated by tests and inspections. Such maintenance keeps the electrical systems in good operating condition and reduces expensive repairs and outages caused by failure of equipment in service.

Efficient equipment management entails responsibility of being alert to new and better ways of carrying out tasks. Example (such as this auger) is equipment of 110-volt generators in operation and maintenance vehicles which are powered by vehicle motor.

Lightning arresters normally require very little maintenance. Usually checking the high-voltage and ground connections and cleaning the insulators are sufficient. However, since an arrester without a good ground is worthless, the resistance to ground should be checked periodically if instruments are available.

Overhead conduit should require little maintenance other than painting and inspection to assure the conduit drains properly. Water, of course, can ruin or short circuit enclosed cables or wires. Buried conduits should be blown out occasionally to determine whether there is water entering through bad connections or perforations caused by electrolysis or rusting.

Motors may run continuously in some areas where the air is dirty; the result is that dirt fills the coils and cooling slots and the motor temperature then rises above normal. Solvents are available for cleaning motors in service.

These solvents are nonflammable and can be used with an air jet to wash the windings and slots. As the solvent is blown in, the rotor will throw it out, carrying the dirt with it. However, the solvent should not enter the oil or grease reservoir and dilute the lubricant, as a bearing may be thus burned out.

For inspection of pumping installations to be effective and beneficial, it must be conducted by competent and interested people from the management level who work closely with the field forces in the operation and maintenance of the irrigation system.

Following inspection, a short discussion should be held by the inspection group regarding conditions found and recommended changes to be made in methods and equipment.

Reports written following inspections are useful in "keeping tab" on deficiencies and act as guides for management to avoid either too much or too little maintenance. The reports can assist management in justifying replacements and improvements.

They are also a reminder of conditions in the field that otherwise might be forgotten. # # #

(This is the second article in a series of four. Part III in the August issue will deal with water measurement procedures.)

Stretching the RAIN in SPAIN

The American Southwest is indebted to Spain for a colorful and romantic heritage, as attested most vividly by the architecture and customs that endure there to this day.

And while it may be a little known feat—viewed in the context of the exploits of the Conquistadores—Spaniards also made their imprint on American irrigation farming. In 1598 they constructed an irrigation ditch on the bank of the Rio Grande near San Juan, Tex.—the first irrigation by Europeans in what is now the United States.

These Spanish pioneers had inherited the tradition and technique of irrigation from the Moors who invaded Spain in the eighth century and brought with them the experience gained through centuries of irrigation in North Africa and the eastern Mediterranean.

Even before the Moors, Spain was the scene of great engineering achievements in connection with water transportation—when the Romans developed aqueducts (at least one still in use today) to bring water to their Iberian cities.

Although Spain has this long history of water development—with irrigation spanning the past 3,000 years—only about one-fourth of the irrigable land has been developed. Present plans, however, call for a threefold increase in irrigation in the foreseeable future. What Spain is doing and will do toward this goal was brought out during an international conference there in the summer of 1960.

Madrid was host city that year for the Fourth Congress of the International Commission on Irrigation and Drainage, which was attended by Commissioner of Reclamation Floyd E. Dominy. This organization, although new, has attracted as delegates to its meeting some of the world's leading authorities in the field of irrigation and drainage. Its next meeting, in 1963, will be on the other side of the world in Tokyo.

Arid Spain, with its many irrigation structures formed an excellent setting for the deliberations of some 800 delegates from 50 countries. Some of the irrigation developments they might well have seen on a tour of Spain are pictured here. Various peoples develop the techniques that are best suited to their own particular needs, and some of the differences between Spanish and United States irrigation methods are noticable in these pictures.

For instance, in Spain greater emphasis is placed on *saving* water; hence, their greater concentration on lining canals and laterals to make them as watertight as possible. The Spanish prefer above-ground construction, allowing leaks to be repaired without delay. Farmers irrigate sparingly, spreading a supply thinly over large areas, thus accepting lower crop yields than an American farmer could afford.

So far, Spanish farmlands have few drainage and salinity problems. The most important reasons are stringent use of water, the extremely low

Directly below: Spanish canal with many drop structures serves irrigated lands on steep hillside. Other photos, counter clockwise: Ancient Segovia aqueduct still conveys municipal water. Canal runs through country similar to American West. Prefabricated,

seepage losses, and a benevolent lack of salt and alkali in the soil. Also, there is comparatively heavy winter rainfall which leaches out the salts brought by irrigation water in the growing season. However, with the introduction of systems more like the American, with the capacity to deliver high heads, drainage may require more consideration than in the past.

As a reminder that water resource development has always been a challenge and that the ability to design durable and effective water-use structures is hardly new, the accompanying illustrations include a view of an aqueduct at Segovia, Spain, near Madrid. Still in perfect working condition, this Roman-built municipal water conveyance system dates probably from the time of the Emperor Trajan (c. A.D. 53–117). It continues to bring water some 10 miles to Segovia from the Rio Frio. The 2,541-foot-long bridge portion crossing the valley into the city consists of a double tier of arches built of granite blocks without benefit of mortar or pins. # # #

above-ground canal illustrates Spanish concern with watertight construction. Farm laterals are also above ground and watertight. Spanish prefer aqueducts to siphons underground. On page 41, siphons, built in 1921, carry irrigation water across arroyos.

farm planning for irrigation development

by D. E. HUTCHINSON, State Soil Conservationist, Soil Conservation Service, Lincoln, Nebraska.

Red Willow County, Nebraska, provides an example of what can be done when farmers go after the assistance they need in the planning and application of soil and water conservation measures. It also shows the value of cooperation not only among farmers but among the agencies serving them.

The landowners of the county—in the McCook area—organized a Soil and Water Conservation District, thereby pooling their interest in "planning for water management." The word "water" is included in the title of such districts in Nebraska in recognition of the prime importance of water control in soil conservation.

Conservation farm plans for water management frequently involve several agencies or groups. Close relationships, for instance, between the Soil Conservation Service and the Bureau of Reclamation have resulted in improved irrigation practices, correlation of design with specific needs and in getting water applied to newly served lands at a rate that is well above average.

With the completion of storage reservoirs by the Bureau of Reclamation, the farmers of Red Willow County looked to the local Soil Conservation Service office for assistance in developing their lands.

Water supplied by the Bureau of Reclamation reaches Red Willow County farmland through facilities of the Frenchman-Cambridge Division, Missouri River basin project.

These Bureau constructed facilities to irrigate Red Willow County lands include the Bartley Canal, that was completed in 1954 with service to 2,000 acres; Meeker-Driftwood system, which was completed during 1958–59 with irrigation service to 11,650 acres; and the Culbertson Extension Canal, which delivered its first irrigation water in 1961 and will irrigate 9,600 acres.

The final feature, Red Willow Canal system, is under construction and will irrigate 4,000 acres, with first water slated for delivery in 1963.

On Charles Barber farm, near McCook, this 45 acres of contour bench leveling was installed last summer and fall. Benches are 24 rows of 40-inch spacing; drop between benches, 1.5 feet. Note how point rows merge into Reclamation canal at left. Other McCook farmers are also developing conservation plans.

The Soil Conservation Service staff assisting the local Soil and Water Conservation District cooperators develop their conservation plans consists of Jim Foster, work unit conservationist; John Frey, conservation engineering technician; and Densel O'Dea, with special help from Glen Buchta, area engineer.

The SCS technicians are developing plans with cooperating farmers for leveling and structural installation prior to delivery of water in newly constructed Bureau of Reclamation canals.

Contour bench leveling is the conservation measure being installed on lands with a slope up to four to five percent. The width of the benches ranges from 12 to 60 rows of 40-inch spacing. The majority of the benches are 16 to 24 rows. They are planned in multiple widths of four rows.

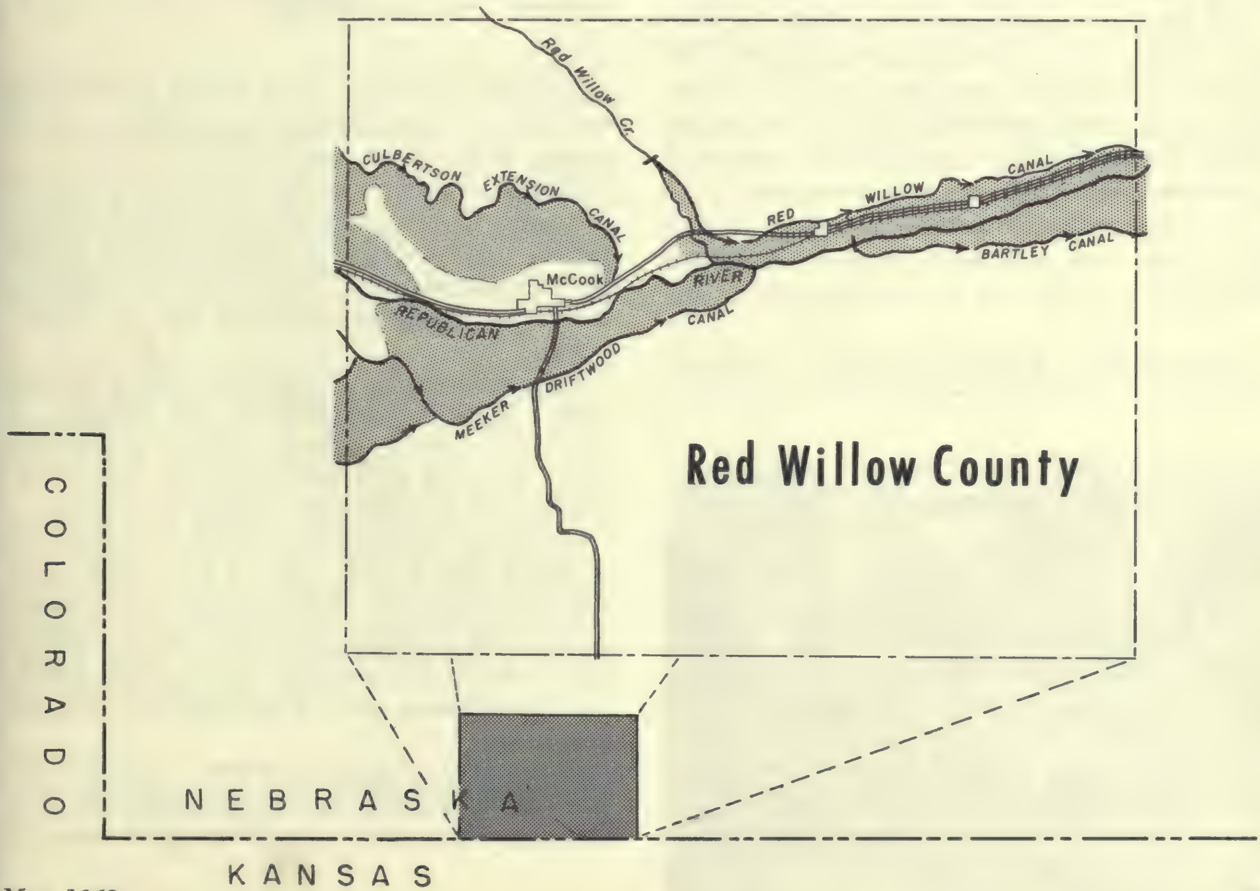
The planning with the farmer is done on detailed topographic maps. Soil and land capability information is provided on the soil survey and land capability map. Irrigable land classification maps are provided by the Bureau of Reclamation.

Five farmers southwest of McCook have jointly developed their conservation plans for water management. In addition to the land preparation, the farmers have cooperated in planning in a unit and installing contour bench leveling, individual farm distribution systems, farm waterways, secondary water courses, road structures, and drop structures. This is in most cases the most efficient and satisfactory way of planning and installing conservation measures for water management.

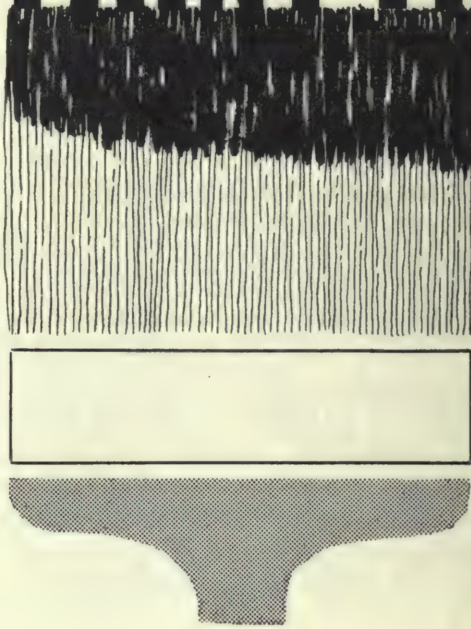
In 1961, 450 acres of contour benching were installed in the Red Willow County Soil and Water Conservation District. This brings the total installed to 1,300 acres. Other conservation measures installed were:

Conventional land leveling—2,400 acres.
Irrigation structures—to serve 550 acres.
Irrigation laterals—50 miles.
Improved water application—5,500 acres.
Terraces—350 miles.
Dams (stockwater and erosion control)—20.
Range seeding—1,300 acres.
Proper range use—40,000 acres.

All of these soil and water conservation measures fit into the overall plan for water management. The measures on the dry croplands and rangeland will reduce flooding and sediment damage to valley lands. # # #



IF IT'S OUTSIDE PAINT IT



That thin protective coating of paint or enamel on your homestead works and field machinery, Mr. Irrigation Farmer, can mean a difference in their life that is measured in years.

If the surface seal is damaged by accident or cracked by age, rust goes to work—and it works 24 hours a day the year 'round.

The research experts of the Protective Coatings Laboratory Section of the Bureau of Reclamation's Engineering Laboratories in Denver would like to pass along some sound advice. They've had years of experience in analyzing the quality and testing the durability of thousands of paints, enamels, and other protective coatings.

Let's take a tour of your farm. First stop, the metal turnout works for your irrigated fields. It'll be either a slide gate or a valve in a length of pipe. If the slide gate was originally galvanized and its coating is damaged, a zinc pigmented paint is good for repairs. If the slide gate was originally painted, you can tell by the color of the undercoat what the original coating was: orange means phenolic red lead; white or gray means vinyl resin.

It's best to use the same kind of paints when repainting. If it's valve and pipe, alkyd red lead primer followed by aluminum paint is recommended. If other galvanized structures, such as windmills and fenceposts, are old and weathered, a zinc dust-zinc oxide paint is the answer.

What about that metal storage tank for water? Vinyl inside and aluminum paint over alkyd red lead primer outside are best. The water pump, piping and associated metals should be alkyd red lead painted and finished with either colored enamel or aluminum paint.

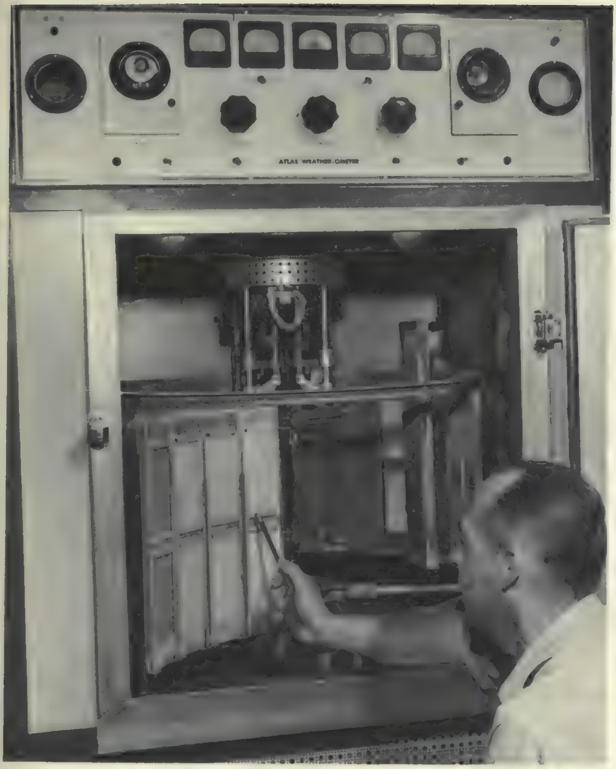
Tractor drawbars need repainting too for longer life. John Miller, Colorado farmer, applies alkyd red lead primer as a beginning.

If any of your underground water pipes run through acid soils—such as chicken yards or stockyards—you can preserve them by covering with coal tar enamel and a felt wrap, or by wrapping them with fiberglass-reinforced coal tar enamel tape.

Your farm machinery left the factory painted with a machinery enamel. If it's damaged or aged, use an alkyd red lead primer on any exposed metal, followed by a complete finish coat of colored enamel, either semigloss or glossy.

For your wooden home, the still preferred method is one or two coats of an oil-base paint over an oil primer. Difficulties have been experienced with emulsion (water thinned) paints applied over old oil-base paint. If your home guttering is weathered, paint it the same way you did your home.

If you have unpainted concrete supports under your windmill, concrete steps to buildings, or a building resting on cinder blocks, you can give



Reclamation technician points out deteriorated paint sample in an accelerated-weathering apparatus at Bureau's Denver laboratories.

weathering resistance with a clear silicone treatment. This not only dampproofs but improves resistance to damage from freeze-thaw cycles.

And what of the roofs over your head? If they are galvanized—new or old—use a zinc dust-zinc oxide primer followed by regular aluminum paint. If they're wood shingled, use a linseed oil type staining treatment. This not only protects cedar shingles, but the new oil renews them.

If your roof is roll asphalt or asphalt shingles in need of help, it's best to replace. Renewing treatments for asphalt roofing now on the market are effective for only a short time.

Finally, if you need to paint concrete or cinder block walls or floors—or repaint them—there are six different approaches. And at this point, we refer you to the new second edition of the *Paint Manual* [1] of Reclamation's Engineering Laboratories. It's the recognized "bible" for anything having to do with painting.

The *Manual* makes recommendations in lay language for the types of paints and other protective coatings; it details how to select, prepare for and apply the proper paints for woodwork, metal, concrete, plaster, and other surfaces.

The *Paint Manual* was prepared by the staff of Reclamation's Protective Coatings Laboratory Section. These are the people who for years have rigorously researched quality and tested paint samples in four different ways: (1) by outdoor weathering, (2) by a laboratory weatherometer which gives an accelerated weather exposure through cycles of wetting and drying and artificial sunlight, (3) by immersion for long periods in a fresh water tank, and (4) by exposure in a fog cabinet which subjects samples to a continuous salt-solution fog.

Painting work on Bureau projects is an important item in construction and overall maintenance operations. The life, safety, operating efficiency, and economy of projects are influenced in considerable measure by the effectiveness of the protective coatings on the structures and equipment. And the *Manual*, of course, was prepared with these objectives in mind.

Before you pick up that paint brush and go to work, let's sum up some general points: First, new paint over old paint should always be the same type as the original. Second, if you need more help, ask your local irrigation district superintendent. Third, and most important of all, to obtain expected service from any protective coating, faithfully follow the prescribed instructions step by step—through selection, surface preparation, and application. # # #

Off-season, January to March, is good time to repaint. Here George Teeter applies primer to turnout works on farm near Denver.

[1] For sale by the Bureau of Reclamation, Denver Federal Center, Denver, Colorado, Attention: 841; or Superintendent of Documents, Government Printing Office, Washington 25, D.C. Price: $1.75.

The APPRAISER'S ROLE in Land Acquisition

by J. LYLE ROBERTSON [1]

Millions of people in the United States are aware, to some degree, of the Bureau of Reclamation's water development activities on Western waterways.

Among these millions, of course, are the direct beneficiaries who receive irrigation water for their farms, municipal water for their expanding cities, hydroelectric power for homes and industrial plants, or protection by controlled riverflows. There are also those who have enjoyed vacation excursions to Reclamation's manmade lakes and recreational areas.

In additon, there are those who are affected in a very different way by Bureau projects. They are the people whose property it is necessary to acquire for sites of reservoirs, dams, canals, pumping plants, substations, or for transmission line and pipeline easements.

Because of the huge population growth in the West and the increasing cost of land, the acquisition of land and rights of way has become a major factor, not only for the Bureau of Reclamation but for other branches of government, quasi-governmental agencies, and private utility organizations.

Water storage projects and appurtenant features, including dam and reservoir sites, lengthy trunkline canals, and power transmission lines, require land or interest in land now in private ownership. Under procedures for the acquisition of such land, the Bureau of Reclamation—as is true of other agencies—depends upon an appraisal as the basis for its negotiations in the purchase of the property.

An appraisal is a supported estimate of the value of an adequately described parcel of property as of a specific date. It is usually a written document containing a complete description, presentation, and analysis of all factual, relevant data resulting in a logical value conclusion.

Real estate appraising as a profession is relatively new, dating back some 30 years when the National Association of Real Estate Boards recognized a twofold problem—the lack of basic standards by which appraisals were made, and a

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[1] Mr. Robertson, the Bureau of Reclamation's Chief Appraiser, based in Denver, has had extensive experience in irrigation, farm management, and land appraisal matters, and is a member of the American Institute of Real Estate Appraisers and other professional organizations.

constant upward trend of real estate prices, placing more emphasis on a supported value estimate.

From this recognition of a great need, appraisal organizations were formed. Groups of real estate men, highly skilled in real estate brokerage and other fields involving value, formulated bylaws, qualifications, standards, and codes of ethics for membership in appraisal organizations. In the succeeding three decades, appraising of real estate has evolved into a highly skilled and recognized vocation.

Keeping pace with this evolution, the Bureau of Reclamation is developing an appraisal training program to help solve its land acquisition problems. Reflecting the importance of uniformly acceptable standard appraisal procedures in the Bureau of Reclamation land acquisition program, a chief appraiser position was established, with headquarters at Denver, Colo. The Chief Appraiser is directly responsible to the Commissioner's office in Washington, D.C.

Working with the Chief Appraiser are the staff appraisers in the Bureau's seven regions. Appraisal training programs in three regions were scheduled for early spring. These were to be followed by periodically scheduled courses in other regions for the purpose of improving the Bureau's appraisal procedures and to standardize appraisal reports to conform with the most acceptable appraisal practices on the professional level.

Staff appraisers in the seven regions have as their responsibility the appraisal of 3,000 to 4,000 parcels of land annually, covering some 100,000 acres, or approximately $10 million in value. The scope of appraisal work indicates clearly the need for continuous training and instruction for appraisers within the Bureau.

Much has been written in the last several years regarding appraisal ethics and the inability of two or more appraisers to concur in a reasonable bracket of value on the same parcel of real estate. A wide divergence in value opinion between two appraisers usually results from differences in the ability of the respective appraisers with regard to the type of property under appraisement.

The appraiser whose practice is confined mainly to large city residential appraisals may be considered as an authority on valuation of such property. However, it does not necessarily follow that he would also be an authority on the valuation of a wheat farm, a cattle ranch, or other strictly rural property.

Since 1902, when the Bureau was established, Bureau of Reclamation appraisals, due to geographic location, have been concerned primarily with the valuation of rural property in the western half of the United States.

The purpose of appraisals likewise has been rather narrowly confined to the definition of just compensation as interpreted through Federal court decisions. Just compensation has been interpreted to be "that amount which is fair and just to the landowner whose property is taken and that amount which is also fair to the public who pays for the property taken."

There are, however, many facets in appraisal procedure, valuation methods, and court decisions with which the appraiser must be familiar. A continuous educational program is a necessity for the appraiser to be adequately informed and competent to perform his function.

The average professional appraiser during the course of his career is requested to make appraisals of all types of real estate property for many and various purposes. Acceptable procedures have been adopted for appraisals for each purpose, but often the procedures change as appraisals are made for different purposes.

An illustration of different procedures might occur when the same building is appraised for (1) book value or depreciation allowance on taxable income, (2) insurable value or replacement cost, or (3) market value—either for sale or purchase. All three estimates of so-called value would be different, due to a difference in the definition of the value sought in the appraisal.

A single concept would appear to simplify the appraisal problem and narrow the bracket of value to the extent that several appraisers would derive relatively the same conclusion. This is true only when the respective appraisers are (1) equally familiar with the area and the type of property under appraisement, (2) equally skilled and trained in appraisal procedure, (3) equally thorough in collecting and analyzing all pertinent data, and (4) equally honest in reporting their value.

The majority of people in the United States recognize the necessity of conserving and developing our water resources. Likewise, the majority recognize the benefits derived from projects which have been completed and which are being built at the present time. Feasibility studies are made on all projects and the economic feasibility of a

project is assured before a project is authorized.

By and large, then, the necessity for the project is seldom questioned by landowners. When final decisions are made on exact locations, maps are prepared, acreage figures are compiled, construction plans are approved, and the acquisition of the land follows in logical sequence.

In designating a site for the dam, reservoir, powerplant, canal system, or other pertinent project features, surface topography allows the engineers little choice in location of such improvements.

Surveyors make only brief contact with landowners on whose lands these improvements will be made. Such landowners have little idea of how much of their land will be required; how it will affect their operations; how much of their ownership will remain useful; or how much they will be paid for property taken and for damage to the remainder.

This is the point where the appraiser enters the picture, equipped with detailed maps, acreage figures and other tools of his trade. He is also prepared to give courteous attention to the landowner's questions.

In the actual process of appraising, the appraiser must thoroughly inspect the property, and there can be no better guide than the owner himself. Particular qualities of the property can be discussed as the inspection proceeds. Cultivated acreages, yields of crops, soil qualities, moisture and fertilizer requirements, drainage, rotation, size of fields, pasture land, carrying capacity, stock water, domestic water, weather conditions, sales in the area of which the landowner has knowledge, age of improvements and many other pertinent elements of the appraisal can be discussed with the owner during inspection of the property.

Land appraising is a matter of applying sound judgment to known facts, resulting in a reasonable estimate of value, and because it reflects judgment it can never be an exact science or a matter of attaining perfection. An appraisal is only as good as the skill, knowledge, diligence, and integrity of the appraiser permits.

The Bureau appraiser does not determine, establish, or create value. His responsibility is to honestly and accurately *measure* the value of property needed by the Government for the benefit of the public, and to strive to maintain and improve understanding between the Government and the public. # # #

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An effective water safety program must be a community-wide effort—sponsored, organized, and supported by many public-spirited groups.

United States Department of the Interior
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Bureau of Reclamation, Floyd E. Dominy, Commissioner

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WATER REPORT

by

HOMER J. STOCKWELL, Staff Assistant, Water Supply Forecast Unit, Soil Conservation Service, Portland, Oreg.

Forecasts of 1962 water supply conditions outlined in this article are based on mountain snowpack measurements and other hydrologic data as of March 1, and a general evaluation of storms in western mountain areas through March 20. Further snow surveys were to be made on April 1 and later dates to measure the total seasonal snowpack. These snow measurements along with other basic data, including antecedent streamflow and precipitation, are used in preparing final streamflow forecasts for the 1962 season.

Snow surveys in Western States are conducted by the Soil Conservation Service, U.S. Department of Agriculture and many cooperating organizations[1] on over 1,400 snow courses and nearly 200 soil moisture stations and related installations. Information for this report was furnished by snow survey supervisors of the Soil Conservation Service for all Western States except California, for which data and information was supplied by the Snow Survey and Water Supply Forecast Unit, Department of Water Resources. Data for this report for *The Reclamation Era* were assembled under the direction of R. A. Work, Head, Water Supply Forecasting Unit, Soil Conservation Service.

OUTLOOK MUCH IMPROVED OVER 1961

Snowpack to mid-March was normal or better over virtually all western mountains.

Seasonal snowfall along the Colorado-Great Basin Divide in Utah and along the Continental Divide in Colorado ranged up to 150 percent of normal. In the Pacific Northwest, including the Columbia River watershed in Montana, seasonal snow accumulation has been near average. Some low snowpack was lost during a warm period in early February which caused local elevation flooding in the Northwest.

Along the Sierra Nevada range in California, snowfall during February and early March totaled up to 300 percent of normal for this period. Unusually heavy storms changed the water supply outlook in California and west-

[1] The Soil Conservation Service coordinates snow surveys conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, and Geological Survey, other Federal Bureaus, various departments of the several States, irrigation districts, power companies, and others. The California State Department of Water Resources, which conducts snow surveys in that State, contributed the California figures appearing in this article. The Water Rights Branch, British Columbia Department of Lands and Forests has charge of the snow surveys in that province.

ern Nevada from what appeared to be a fourth year of extreme drouth to near or above normal conditions.

Winter snowfall and spring runoff have been well above average in Arizona. Storage on the Salt River project is near 150 percent of average. Outlook from surface water supplies is the best for several years.

Flow of all streams out of Colorado and Wyoming mountains, on both sides of the Continental Divide, are forecast at much above normal for 1962. In addition to above normal snowpack, soils in both mountain and irrigated areas are relatively wet from fall and mid-winter storms. Water supplies should be adequate for all needs. If the rate of snowpack accumulation continues, there may be some concern about high water in local areas.

River flow of the upper Missouri and Columbia and their tributaries in Montana is expected to be near average for 1962, providing generally adequate water supplies and for restoring reservoirs to near average operating levels.

Average water supplies are in prospect for the main irrigated areas along the Snake River through Idaho. While water supply forecasts are for somewhat less than average flow in Oregon and Washington, only local, limited water shortages are expected to occur. Less than average streamflow is forecast for the Humboldt in Nevada and some streams flowing east from the Sierras.

Outlook for 1962 is in direct contrast to that of a year ago, which was a third drouth year for a wide area, including California, Nevada, and Utah and, to a lesser extent, adjacent States. In 1961, only the northern Columbia Basin and streams east of the Colorado mountains had really satisfactory water supplies.

RESERVOIR STORAGE LOW

When the irrigation season ended last year, 200 representative irrigation reservoirs in Western States had only about 40 percent of the usual carryover storage. Storage in some reservoirs in drouth areas were exhausted. There has been an improvement in storage conditions during the winter months, but much-above-average runoff will be required to restore some reservoirs in the drouth areas to the normal operating levels.

Water users in areas previously short are fortunate to have prospects of restoring normal storage in only 1 year.

Many areas of the West have water demands exceeding supplies in most years. Agricultural water users, in particular, can take advantage of a reasonably good outlook this year to effect plans delayed for want of a dependable water supply. Waste should be avoided, not only because it damages land and affects quality of water, but also to build up storage reserves for a year or more in advance.

WATER SUPPLY FORECASTS

Details on local water supply outlook conditions may be obtained from Work Unit Offices of the Soil Conservation Service, Federal water agencies, State and local water officials, and managers of irrigation or water districts.

Forecasts for major streams, for the April–September 1962, period, follow, with comparisons to normal (1943–57). The forecasts indicate general water supply conditions on major watersheds, but do not always reflect correctly local conditions.

Columbia River at The Dalles, Oreg., 93,000,000 acre-feet or 88 percent

Missouri River at Zortman, Mont., 4,850,000 acre-feet or 101 percent

Rio Grande at Otowi Bridge, N. Mex., 1,000,000 acre-feet or 158 percent

Colorado River near Grand Canyon, Ariz., 14,500,000 acre-feet or 158 percent

San Joaquin River inflow to Friant Reservoir, California,* 1,440,000 acre-feet or 117 percent

Sacramento River inflow to Shasta Reservoir, California,* 1,815,000 acre-feet or 100 percent.

All forecasts are subject to correction for change in storage in upstream reservoirs.

In the following paragraphs the outlook by States is briefly reviewed.

ARIZONA—The water supply outlook for Arizona is very good. Heavy runoff has occurred in recent weeks with additional storms replacing snow that has melted. Storage on the Salt River project is 143 percent of average. San Carlos Reservoir on the Gila has 165 percent of normal storage, but only 14 percent of capacity. Streamflow during the spring months is forecast in the range of 115 percent of normal for the Tonto and Verde Rivers to 210 percent of normal for the Gila.

CALIFORNIA—The California Department of Water Resources reports that the drouth of the past 3 years has ended. March 1 hydrologic data indicates that streamflow and water supply conditions will be near or above normal for all areas of the State in 1962.

Water supply outlook improved dramatically during February. Precipitation and snowfall amounts ranged from 225 percent of normal in the northern Sierras to 275 percent of normal in the south. Rainfall amounts up to 500 percent of normal were received in southern California during February.

The significant feature of these statewide storms is that the southern part of the State received relatively greater precipitation amounts than the north. This is a desirable (but seldom realized) situation for the arid area of southern California.

Precipitation continued above normal during the first half of March. This occurrence tends to make forecasts made as of March 1 slightly on the conservative side.

Forecasts of April–July streamflow as of March 1 range from normal for the upper Sacramento River watershed to about 115 percent of normal for the southern central valley streams, the San Joaquin, Kings, Kaweah, Tule, and Kern Rivers.

COLORADO—Colorado should have the best water year since 1957 and one of the better years in recent times. Snowpack in all areas of the State is at least normal with some snow course measurements approaching a maximum of record as early as March 1. Reservoir storage is better than last year and average. All irrigation reservoirs are

Continued on page 54

*April–July.

In his recent conservation message to the Congress, President Kennedy said: "Adequate outdoor recreational facilities are among the basic requirements of a sound national conservation program. The increased leisure time enjoyed by our growing population and the mobility made possible by improved highway networks have dramatically increased the Nation's need for additional recreation areas. The 341 million visits to Federal land and water areas recorded in 1960 are expected to double by 1970 and to increase fivefold by the end of the century."

These two photographs, taken on the Bureau of Reclamation's Colorado-Big Thompson project in Colorado, indicate how Reclamation projects are already doubling as recreation areas, in addition to their primary purposes. Above, the Annual Regatta at Grand Lake Yacht Club, the world's highest. At right, Howard Homyak of Englewood, Colo., with 8 fish to show for his time enjoyed at Horsetooth Reservoir.

# # #

Water Report

Continued from page 52

expected to fill during the snowmelt runoff period. If the seasonal rate of snow accumulation continues above normal some local damage from high water may be anticipated.

IDAHO—Irrigation lands in Idaho should have a relatively normal water supply for the 1962 season. Unseasonable floods in eastern Idaho during February increased reservoir storage significantly along the Snake River and its tributaries. The areas of critically short water supplies last year, such as the Big Wood, Big Lost, and Owyhee Rivers and Salmon Falls Creek have a snowpack that is normal or above this season. Soil moisture conditions are much improved over a year ago, but could be better in most irrigated areas.

KANSAS—With the inflow to John Martin Reservoir in Colorado forecast at well above normal, irrigation water supply along the Arkansas River in western Kansas should be at least average in 1962.

MONTANA—Snowpack in Montana mountain areas is generally slightly above normal. Streamflow forecasts are also near or above normal. Flows will be up to twice that which occurred in the drouth year of 1961, particularly east of the Continental Divide. Soil moisture is good. Very little snowmelt water will be required to replace soil moisture deficits.

Storage in irrigation reservoirs is generally below average, but prospects for these reservoirs to fill during the spring months are good.

NEVADA—As a result of a near unprecedented increase in snowpack during February and early March, near normal runoff is expected for most Nevada streams. Forecasts for the April–July 1962 period range from 75 percent of normal on the lower Humboldt to 125 percent of normal on the Truckee River. Reservoir storage is seriously depleted. Allotments from this source will be much less than normal. The total reservoir storage and prospective streamflow add up to a fair to good water supply this next season.

NEW MEXICO—Reservoirs are filled to near capacity for the Tucumcari project and along the lower Pecos. With above normal snowmelt runoff in prospect, a good water supply is assured.

Even the heavy water demand area along the Rio Grande has a good water year in prospect. If the remainder of the snow season is near average, total streamflow may be in excess of any year since 1952. Storage in Elephant Butte is down to near 400,000 acre-feet and there is no reasonable expectation of filling this reservoir from snowmelt.

OREGON—The 1962 irrigation water supplies for Oregon should be adequate, although there will be need for careful management to stretch the available water in some areas of the State. Shortages of carryover storage may limit total water supply in some southeastern counties and one or two other local areas. On the desert watersheds, soils are wet and should warm winds or heavy rains occur, heavy runoff could be obtained from low elevations. Storage statewide is only 63 percent of normal and a little less for this date a year ago. Forecasts of streamflow are generally near but slightly below normal.

UTAH—The water supply outlook for Utah is good to excellent and in direct contrast to the outlook as of a year ago. Snowpack has been generally 25 to 50 percent above normal. Mountain soils are wet. Earlier in the season it appeared that some irrigated areas might have a short water supply because of extreme deficits in reservoir storage. February increment in snowfall was far in excess of average, largely removing any probability of water shortage. Carryover storage into the 1963 season should be much improved.

WASHINGTON—Streamflow during recent weeks has been well above normal due to melting of low level snowpack. Forecasts for the snowmelt season are generally in the range of 70 percent to 100 percent of normal. Snowpack and soil moisture under the snow is relatively deficient on the Okanogan-Methow rivers in north central Washington and on the Walla Walla River in the southeast on the Washington-Oregon border. These areas have possible water shortages in prospect. In the major irrigated areas water supplies will be adequate. Power reservoirs are expected to fill.

WYOMING—As of March 1, all streamflow forecasts were for above normal streamflow during the snowmelt season. Forecasts along the North Platte and Laramie, where normal demand and supply tend to balance, streamflow is expected to range from 130 to 150 percent of normal. Similar flows are expected for the Green River watershed of the Colorado River, with near normal flows in prospect for the Big Horn and its tributaries.

Except for the Laramie River, storage in all reservoirs within the State is well below average. Improvement is expected a year hence after it has been possible to store some of the excess flow anticipated for 1962. # # #

NEW MOTION PICTURES

Two new Bureau of Reclamation motion pictures are now available.

Water for the Valley details the progress and plans for the Bureau's Central Valley project in California. *Operation Glen Canyon* tells the story of construction at Glen Canyon Dam, Ariz., key unit in the Colorado River storage project.

Schools and organizations interested in conservation, or their representatives, may borrow the motion pictures by addressing a request to: U.S. Department of the Interior, Bureau of Reclamation (Att. 915), Washington 25, D.C. The only expense to the borrower is return postage.

# # #

The Bureau of Reclamation estimates that with continued research and development of a full-scale program in evaporation reduction, it might be possible to save about 2 million acre-feet of water annually in the 17 Western States by 1980.

Left to right: Harry W. Kelly and award winners, Ivan D. Wood, E. O. Daggett, Arno Windscheffel, and Earl T. Bower.

With the Water Users

At the Four-States Irrigation Council's 11th annual meeting in Denver in January, four awardees received the council's "Headgate Award" for outstanding service in expanding the scope and improving the efficiency of use of water for irrigation. Harry W. Kelly of Wyoming, president of the council, presented the awards to Ivan D. Wood, Colorado; E. O. Daggett, Nebraska; Arno Windscheffel, Kansas; and Earl T. Bower, Wyoming. Assistant Secretary of the Interior Kenneth Holum, was the principal speaker at the banquet.

☆ ☆ ☆

The National Reclamation Association will hold its 1962 convention in Portland, Oreg., during the week beginning October 14. The early dates were selected so that those NRA delegates who wished to do so could plan their trip to include both the convention and the Seattle World's Fair which ends October 21. Marshall N. Dana, Portland, Oreg., first president of the National Reclamation Association, is general chairman in charge of convention arrangements.

☆ ☆ ☆

The "Current News", an employee magazine published by the Salt River project in central Arizona, recently received recognition for outstanding accomplishment in industrial editing in competition with publications in 11 States. The award was presented by the Southwest Conference of Industrial Editors of 1961 to Editor Paul Selonke.

☆ ☆ ☆

Trenton Dam and Swanson Lake, on the Republican River in southwestern Nebraska, furnished the subject matter for Nebraska University's Engineering Open House winning exhibit. Dan B. Grubb, McCook, Nebr., an engineering student, assisted by other civil engineering students, built the winning model. # # #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DS-5653	Central Valley, Calif.	Jan. 4	Three 39,000/52,000/65,000-kva power transformers for Spring Creek powerplant.	Westinghouse Electric Corp., Denver, Colo.	$368, 948
DC-5700	Colorado River Storage, Utah-Wyo.	Feb. 2	Completion of Flaming Gorge powerplant and switchyard.	Gunther and Shirley Co. and E. V. Lane Corp., Sherman Oaks, Calif.	1, 971, 824
DC-5701	Missouri River Basin, Nebr.	Jan. 19	Construction of earthwork and structures for Farwell main laterals and Farwell lower main laterals, second section.	Bushman Construction Co., St. Joseph, Mo.	1, 557, 149
DC-5703	Weber Basin, Utah	Feb. 16	Construction of earthwork, pipelines, and structures for Woods Cross lateral system, Part 2.	Statewide Contractors, Inc., Murray, Utah.	615, 831
DC-5708	Missouri River Basin, N. Dak.	Jan. 30	Stringing conductors and overhead ground wires for 138 miles of Garrison-Jamestown 230-kv transmission line.	Commonwealth Electric Co., Lincoln, Nebr.	217, 408
DC-5710	Colorado River Storage, Colo.-N. Mex.	Jan. 2	Constructing foundations and furnishing and erecting steel towers for 42 miles of Shiprock-Cortez section of Shiprock-Curecanti 230-kv transmission line.	Irby Construction Co., Jackson, Miss.	759, 410
DS-5714	Colorado River Storage, Utah-Wyo.	Jan. 26	Four 138-kv power circuit breakers for Flaming Gorge switchyard.	Westinghouse Electric Corp., Denver, Colo.	100, 524
DC-5715	Lower Rio Grande Rehabilitation, Tex.	Jan. 29	Clearing, and construction of earthwork, concrete lining, and structures for rehabilitation of L and I-14 lateral systems.	E. & M. Bohuskey Construction Co., Harlingen, Tex.	364, 001
DC-5717	Colorado River Storage, Utah-Wyo.	Mar. 13	Furnishing and installing a passenger elevator for Flaming Gorge dam.	Montgomery Elevator Co., Denver, Colo.	118, 967
DC-5718	Central Valley, California.	Feb. 13	Construction of reservoirs Nos 1 and 7 water treatment stations for El Dorado distribution system.	Baldwin Contracting Co., Inc., Marysville, Calif.	134, 200
DS-5721	Colorado River Storage, Ariz.-Utah	Feb. 21	Six 345-kv power circuit breakers for Glen Canyon switchyard.	General Electric Co., Denver, Colo.	894, 230
DC-5727	Colorado River Storage, Colo.-N.Mex.	Mar. 7	Laying track and ballasting for relocation of 11.65 miles of Denver and Rio Grande Western Railroad.	Wm. A. Smith Contracting Co., Inc., Kansas City, Kans.	239, 434
DS-5730	Missouri River Basin, Mont.-Wyo.	Mar. 16	Two 84-inch ring-follower gate valves and two bellmouths for river outlets at Yellowtail dam.	Goslin-Birmingham Mfg.Co., Inc., Birmingham, Ala.	176, 668
DS-5732	Colorado River Storage, Ariz-Utah	Mar. 16	One 4,160-volt switchgear assembly and nine station-service and lighting unit substations for Glen Canyon powerplant.	Allis-Chalmers Mfg. Co., Denver, Colo.	173, 885
100C-499	Columbia Basin, Wash.	Jan. 3	Construction of concrete lining for W44A lateral, Block 77.	S&S Sand and Gravel, Inc., Ephrata, Wash.	103, 619
300C-157	Colorado River Front Work and Levee system, Ariz.	Jan. 19	Construction of earthwork and riprap for South Gila levee.	Frank G. Furman, Roberts Co., Lowe & Watson, and Lowe & Watson Construction Co., Inc., San Bernardino, Calif.	683, 794
400C-187	Colorado River Storage, Colo.	Feb. 19	Construction of prefabricated-metal service building and five 6-stall and two 4-stall garages; and remodeling 11 buildings for Blue Mesa construction camp.	D. A. Mazzocco Construction Co., Gunnison, Colo.	112, 063
500S-118	Lower Rio Grande Rehabilitation, Tex.	Feb. 16	Unreinforced and reinforced concrete pressure pipe and concrete culvert pipe for La Feria division.	W. T. Liston Co., Harlingen, Tex.	368, 149
617C-70	Missouri River Basin, Wyo.	Feb. 28	Construction of 7.9 miles of open and closed drains and surfacing area around Bluff pumping plant No. 2.	T. R. Munsinger & Sons, Glenrock, Wyo.	116, 311
DC-5726	Missouri River Basin, Kans.	Mar. 29	Construction of earthwork and structures for Cedar Bluff canal, Sta. 569+00 to 954+00, Cedar Bluff laterals 2.6 to 17.3, inclusive, sublaterals, wasteways, and drains.	Harry Henery, Inc. Herington, Kans.	652, 964
DC-5733	Florida, Colo.	Mar. 30	Construction of earthwork and structures for Florida Farmers Ditch diversion dam and ditch enlargement, Sta. 1+49 to end; and enlargement of Florida canal, Sta. 0+00 to 100+20.3.	A. S. Horner Construction Co., Inc. and Colorado Constructors, Inc., Denver, Colo.	1, 042, 604
DS-5758	Central Valley, Calif.	Mar. 29	Eleven 60-foot by 18-foot fixed-wheel gate frames for overflow weir and sluiceway at Red Bluff diversion dam.	Truitt Metal Fabricators, Inc., Greensboro, N.C.	129, 950
200C-491	Central Valley, Calif.	Mar. 26	Construction of earthwork, structures, and surfacing for relocation of 2.2 miles of Shasta County Brandy Creek road.	Ray Kizer Construction Co., Yreka, Calif.	265, 032

The Bureau of Reclamation's 60th Birthday Is June 17, 1962

Major Construction and Materials for Which Bids Will Be Requested Through May 1962*

Project	Description of work or material
Avondale, Dalton Gardens, and Hayden Lake Distribution Systems, Idaho.	Furnishing and laying about 36 miles of pipe including turnout and drain connections, removing existing corroded distribution lines and valves, cleaning and reinstalling gate valves of various sizes, and furnishing and installing new gate valves. Eight miles north of Coeur d'Alene.
Central Valley, Calif.	Constructing about 5 miles of 30- to 48-in.-diameter cast-in-place concrete pipelines, about 4 miles of 12- to 84-in.-diameter precast-concrete pressure pipelines, and about 4 miles of open canal with bottom widths varying from 12 to 6 ft, and appurtenant structures, including a 12-cfs-capacity pumping plant. Madera Extension (Unit 3), near Madera.
Do	Constructing about 4 miles of canals with bottom widths varying from 8 to 3 ft, about 14 miles of earth dikes with top width of 12 ft and heights varying from 10 to 3 ft, drilling or jetting about 85,000 lin ft of infiltration holes and installing 4-in.-diameter perforated pipe surrounded by gravelly materials. Holes will average about 75 ft deep. San Luis Canal, near Los Banos.
Do	Earthwork, culverts, and plant-mix bituminous surfacing for about 3 miles of temporary detour on State Highway No. 152. About 12 miles west of Los Banos.
Do	Frames for eleven 60- by 18-ft fixed-wheel gates for the overflow weir and spillway at Red Bluff Diversion Dam. Estimated weight: 420,000 lb.
Do	Eight Francis-type, vertical-shaft pump turbines each with a pumping capacity of 1,375 cfs at a total head of 290 ft for the San Luis Pumping-Generating Plant.
Chief Joseph Dam, Wash.	Constructing a caretaker's residence, shed and other facilities for the Howard Flat Unit, near Chelan.
Colo. River Storage, Ariz.	Furnishing and installing fence gates; clearing right-of-way; constructing concrete footings; designing, testing, furnishing and erecting steel towers; and furnishing and stringing ACSR and steel overhead ground wires for about 247 miles of 345-kv, single-circuit Glen Canyon-Pinnacle Peak Transmission Line. From the Glen Canyon Switchyard to vicinity of Flagstaff, thence to vicinity of Phoenix, Ariz.
Do	Completion work for the Glen Canyon Powerplant. Completion work for the switchyard.
Colorado River Storage, Ariz.	Three 345- to 230-kv, 100,000-kva, single-phase autotransformers for the Glen Canyon Switchyard.
Do	Three 230- to 13.8-kv, and nine 345- to 13.8-kv, 90,000-kva, FOW, single-phase power transformers for the Glen Canyon Powerplant.
Do	Four 230- to 138-kv, 20,000-kva, single-phase autotransformers for the Glen Canyon Switchyard.
Do	Constructing radio huts and towers at four sites for controlling construction of the Glen Canyon-Shiprock Transmission Line. From Page, Ariz., to Shiprock, N. Mex.
Colorado River Storage, Colo.	Furnishing and installing fence gates, clearing right-of-way, constructing concrete footings, furnishing and erecting steel towers, and furnishing and stringing three 1,272 MCM, ACSR, and two 0.5-in. steel overhead ground wires, complete with accessories, for about 160 miles of the Curecanti-Craig 230-kv, single-circuit transmission line. From a point about 3 miles east of Montrose, to the vicinity of Craig.
Do	Constructing Craig Substation (Stage 01).
Colorado River Storage, N. Mex.	Constructing a 1,300 sq ft masonry-veneer residence and remodeling existing concrete-block laboratory into O&M service building. Navajo Damsite, about 39 miles east of Farmington.
Do	Three 37,500-kva, 230- to 115-kv, single-phase autotransformers for the Shiprock Substation.
Columbia Basin, Wash.	Constructing the Moses Lake control works. Near Moses Lake.
Do	Constructing the indoor-type Sagemoor Pumping Plant with a reinforced concrete substructure and a structural steel superstructure with reinforced concrete masonry walls and a wood roof deck. Furnishing and installing four motor-driven pumping units of 88-cfs total capacity, and mechanical and electrical auxiliary equipment. Work will also include furnishing and installing concrete pipe discharge line, constructing concrete outlet transition and 300-ft of earth-lined canal. Near Pasco.
Fort Peck, Mont.	Constructing the Richland Substation. At Sidney.
Middle Rio Grande, N. Mex.	Clearing about 5,000 acres of phreatophytes for water consumption and use studies. On the Rio Grande, about 55 miles south of Albuquerque.
MRBP, Kans.	Constructing Norton Dam, a 3,300,000-cu-yd earthfill structure, 100 ft high and 6,520 ft long, and appurtenant works. On Prairie Dog Creek, bout 2.5 miles southwest of Norton.
Do	Earthwork, structures, and surfacing for about 2 miles of county road relocation; constructing two timber bridges. Near Norton.
MRBP, Mont.	Four Francis-type, vertical-shaft hydraulic turbines rated 70,000-hp at 420-ft net head for Yellowtail Powerplant.
MRBP, Nebr.	Earthwork and structures for about 16.3 miles of unlined canal with bottom widths varying from 14 to 3 ft and about 32 miles of unlined open laterals with bottom widths varying from 5 to 3 ft. Farwell Central Canal, near Farwell.
Do	Earthwork and structures for about 14 miles of concrete-lined canal with bottom width of 9 ft and concrete lining height of 8.4 ft. Ainsworth Canal, near Valentine.
Norman, Okla.	Constructing Norman Dam, a 2,700,000-cu-yd earthfill structure, 100 ft high and 7,400 ft long, and appurtenant structures. On Little River, about 13 miles east of Norman.
MRBP, S. Dak.	Constructing about 96 miles of wood-pole, H-frame Winner-Mission-Martin 115-kv transmission line complete with three 397.5 MCM, 26/7, ACSR, and two 3/8-in. steel overhead ground wires.
Seedskadee, Wyo.	Earthwork and structures for about 8 miles of 35-ft bottom width canal, 1.3 miles of which is to be earth lined. West Side Canal, near La Barge.
The Dalles, Oreg.	Two electric motor-driven, vertical-shaft, turbine-type pumping units each with a capacity of 18.07 cfs at a total head of 228 ft; one electric, motor-driven, vertical-shaft, turbine-type pumping unit with a capacity of 9.02 cfs at a total head of 228 ft; and two electric, motor-driven, vertical-shaft, turbine-type pumping units each with a capacity of 4.52 cfs at a total head of 228 ft. All for the Mill Creek Pumping Plant.
Weber Basin, Utah	Constructing Causey Dam, a 1,330,000-cu-yd earthfill structure, 200 ft high and 900 ft long, and appurtenant works. On the South Fork of the Ogden River, about 18 miles east of Ogden.
Do	Completing Willard Dam by adding 3,800,000 cu yd of earthfill to the existing embankment. This additional fill will raise the height of the structure to 34 ft and will extend the crest length to 75,000 ft. At Willard Bay, 11 miles northwest of Ogden.
Do	Earthwork and structures for about 7.7 miles of earth-lined canal with bottom widths varying from 10 to 3 ft and replacing an existing diversion structure with a concrete diversion structure with a canal headworks structure on each side of the river. Near Ogden.
Weber Basin, Utah	Constructing the Layton Pumping Plant, an outdoor-type, reinforced-concrete substructure plant on a pile foundation, with four motor-driven pumping units of 277-cfs total capacity. West of Ogden.
Do	Enlarging about 9 miles of Willard Canal from an 8- to a 30-ft bottom width, constructing about 2 miles of new canal with a 30-ft bottom width, constructing appurtenant structures, and earth lining the entire length. Near Ogden.

*Subject to change.

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Reclamation ERA

AUGUST 1962

The Reclamation Era

AUGUST 1962 **VOLUME 48, NO. 3**

In this issue . . .

VIOLET PALMER, Editor
KATHRYNE DIMMITT, Art Editor

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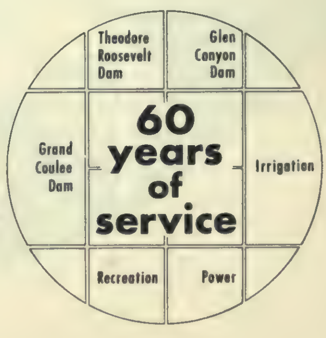

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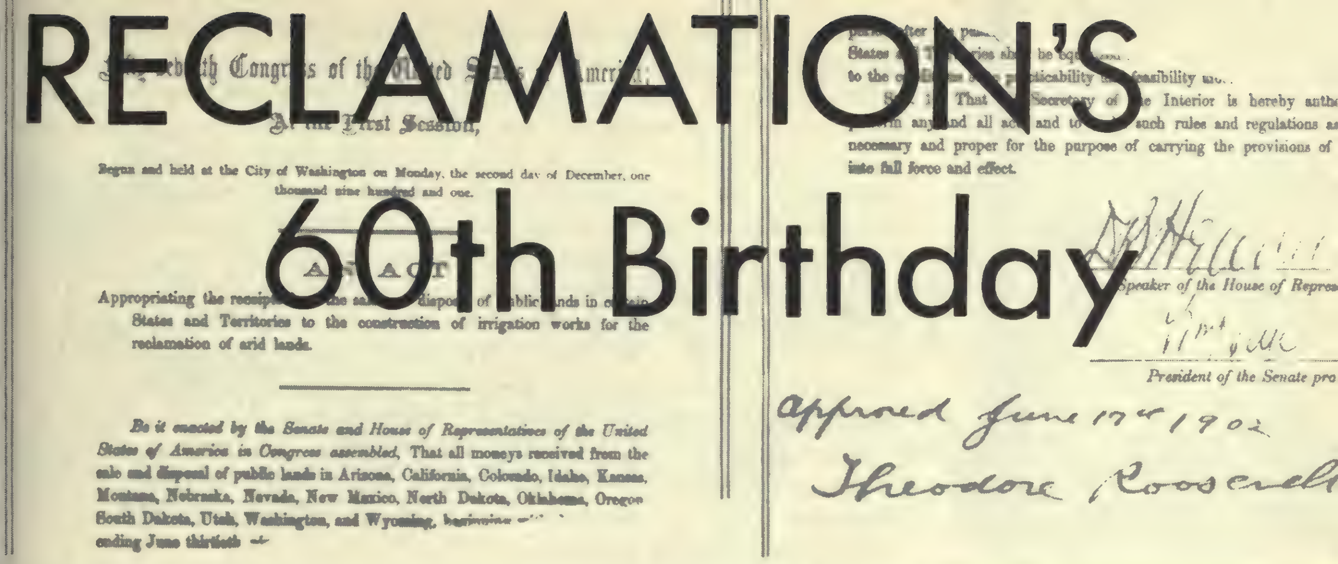
RECLAMATION'S 60th Birthday



[illegible] Congress of the United States of America;
At the First Session,

Begun and held at the City of Washington on Monday, the second day of December, one thousand nine hundred and one.

AN ACT

Appropriating the receipts [illegible] sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That all moneys received from the sale and disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon South Dakota, Utah, Washington, and Wyoming, [illegible] ending June thirtieth [illegible]

[illegible] after [illegible] States [illegible] shall be equ[illegible] to the [illegible] practicability [illegible] feasibility [illegible]

S[illegible] That [illegible] Secretary of [illegible] Interior is hereby auth[illegible] [illegible] any and all acts and to [illegible] such rules and regulations as necessary and proper for the purpose of carrying the provisions of [illegible] into full force and effect.

Speaker of the House of Repres[illegible]

President of the Senate pro [illegible]

Approved June 17th 1902

Theodore Roosevelt

This year the United States is marking the 60th anniversary of one of the most significant milestones in the history of water resource development. On June 17, 1902, the Federal Reclamation Act was signed into law by President Theodore Roosevelt and became the cornerstone for a considerable part of the progress achieved in the 20th century by the western United States.

While the primary importance of the Reclamation Act of 1902 lies in its initiation of an orderly program of water resource development in the 17 Western States, it was also the first truly national expression of concern with water, along with land, as the most basic of all resources.

The Bureau of Reclamation—known at first as the Reclamation Service—had its inception in the act of 1902 and for six decades has been planning, researching, and building in the field of water development. Today the Bureau is known worldwide for its success in this field and for the benefits that its projects in the Western States have brought to the Nation.

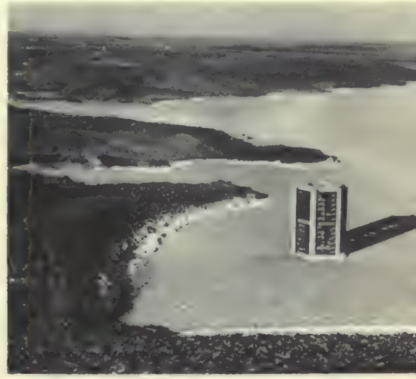
Seeking after an adequate water supply has been a part of everyday life to people in the western half of the United States from the time the first settler crossed the 97th meridian.

The East has been blessed more abundantly with rainfall but, even in humid areas, the people are coming to the realization that the bounty of their rivers is not endless without proper utilization. Rapidly increasing population, intensive urbanization, and greater industrial use of water are requiring more attention to water conservation all across the Nation.

The Bureau of Reclamation takes into consideration and builds into its water projects the multiple-use structures necessary to provide as many benefits as economics and technology will permit.

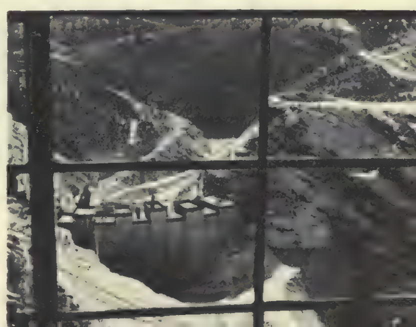
In the past 60 years, thousands of acres of barren desert land have been transformed into fertile farms by the exercise of human initiative in the application of irrigation water. Much has been done through individual and group effort, and also through construction of Bureau of Reclamation projects.

These Reclamation projects are helping fill the current great need for municipal and industrial water and for hydroelectric power, as well as



Storing of municipal, industrial water (as at i[illegible] Reservoir, Okla.) is important Reclamation fu[illegible]

Dams produce power, irrigate crops, bring [illegible] benefits. Above, bridge at Glen Canyon Dam[illegible] Below, Flaming Gorge Dam, Utah, from vista [illegible]



to bring a supplemental water supply to land already under cultivation but with insufficient water for maximum efficiency.

But much still remains to be done. Reclamation is a continuing process. The need is evident in the predictions that by the year 2000 the Nation's population will have risen to probably 380 million people and the demand for water will have tripled over present withdrawals. Add to this the problem of feeding more people from farm acreage which is being constantly whittled away by urbanization, and the necessity for making the land as productive as possible becomes clear.

While the Nation as a whole is increasing its population to a projected 380 million, growth of the 19 Western States (including Alaska and Hawaii) will be even more spectacular, going from 45 million to 111 million people by the year 2000.

Most of the easier and lower cost developments in the West have now been carried out, but the need for water continues to increase. To meet this need, larger and more complex works are being built and basinwide development is being undertaken.

Land is being shifted to nonagricultural uses at an accelerating rate, and considering population projections, greater efficiency will be needed on the land remaining in agricultural production in order to assure a plentiful future food supply. Successful farming operations require a dependable water supply. This allows a farmer to diversify his production to meet market demands.

Most irrigation development now being planned or constructed would not add to the existing crop land, but would supply new or supplemental water to land already being cultivated.

Unless and until space exploration opens up new territorial frontiers on other planets, inhabitants of this earth have only one real material frontier onto which to expand. And that is the frontier of improvement in the way the earth's natural resources are handled. America's challenge, then, is not only to explore new worlds, but to improve and make more useful what is already available on this world. # # #

HAWAII'S Molokai Project

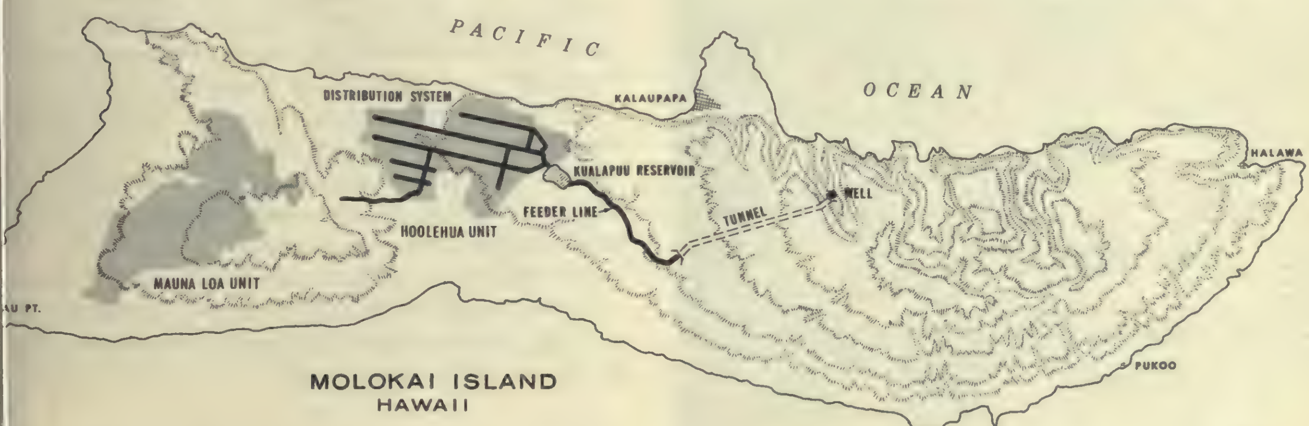
The lament of Coleridge's Ancient Mariner of "Water, water 'everywhere, but not a drop to drink" has worldwide significance—for, often, it is not the lack of water that troubles mankind, but the problem of providing it at the right place, at the right time, in the right amount, and in the right quality. Even America's newest State, Hawaii, lying in the middle of the Pacific Ocean and in the path of moist trade winds, has found that an abundance of rain is of little avail if the rain falls at the wrong place.

On the windward side of this beautiful chain of islands, the gray rainclouds roll in low, almost like fog, and, clustering around the volcanic mountaintops and against high cliffs, lose much of their moisture there. This makes for lush and varied flora in the narrow valleys that are slashed into the windward sides of the mountains by precipitous streams. But it leaves some of the good farmland on the leeward side of the islands with inadequate rainfall for efficient crop growing. This is the case on all of the islands including Molokai, the fifth largest island in the semitropical Hawaiian group.

Molokai is 25 miles southeast of Oahu, the island on which is located the capital city of Honolulu (and Waikiki Beach).

The topography of Molokai is dominated by the three now extinct volcanoes that formed the 260-square-mile island. Between two of the volcanic mountains is the Hoolehua plain which came into existence, essentially, when lava from the easternmost volcano ponded against the flank of the volcano on the west. It is this area and the adjoining Mauna Loa area that constitute a good opportunity for further agricultural development on Molokai.

Because precipitation varies greatly within short



MOLOKAI ISLAND
HAWAII

distances on the island—depending on altitude and exposure to the trade winds—a dependable water supply at the right place is a prerequisite for efficient, economical development.

The area of maximum precipitation on the east receives an average of over 200 inches of rain per year. The driest part of the island, on the leeward southwest corner, receives about 10 inches of rainfall annually, and much of this may result from only three or four storms.

Some system for more evenly distributing the moisture was obviously necessary and the Territory of Hawaii, now the State of Hawaii, began to take steps, with the cooperation of the Bureau of Reclamation, to remedy the situation.

In 1955, a study of a proposed Molokai irrigation project was made by the Bureau under the provisions of Public Law 634, 83d Congress. The Bureau's Molokai report which was published in 1957 concluded that the project was economically feasible.

The plan that evolved for the project envisioned construction of a 5-mile tunnel, through the mountains from the Waikolu Valley on the wet windward side of Molokai, to bring water from streams and wells to the dry but fertile plain on the leeward side.

The Waikolu Valley Stream, on humid side of island of Molokai, is water source for the 50th State's small reclamation project.

Other works that would be required included 7 miles of main supply lines to bring water from the tunnel to the service area, a storage reservoir, and distribution lines in the service area, and various diversion works and wells at the source in Waikolu Valley.

Subsequently, in 1957, Hawaii went to work to construct the project, relying on a $5 million bond issue for initial funds. Because the total cost of the project is estimated at $9,910,000, other means of financing were also needed, and the Small Reclamation Projects Act of 1956 (Public Law 984, 84th Cong.) seemed to State officials the best route to take. In 1960 the Congress extended that act to Hawaii as part of the Hawaii Omnibus Act (Public Law 86–624).

Under the Small Reclamation Projects Act, the Bureau of Reclamation is authorized to lend and grant up to nearly $5 million to a local organization for the construction or rehabilitation and betterment of a project primarily for irrigation with a combined Federal-local cost of not more than $10 million. The participating local water-user groups or State agencies plan and build their own projects. Nonreimbursable funds may be granted for flood control and fish and wildlife features that are of a general public benefit.

Hawaii applied for a Small Projects loan of $4,514,000 and in March 1962 the application was approved by the Department of the Interior. The Molokai project is exclusively for irrigation and the full amount of the loan is to be repaid by the water users.

When the loan application was approved by Interior, the State had already virtually completed construction of the tunnel to divert water from the north side of the mountains to the dry plain, as well as some other portions of the supply works.

The Federal loan was needed to assist in financing construction of the remaining facilities, consisting chiefly of distribution system, the Kualapuu reservoir, and portions of the supply canal system.

Water will be delivered to the edge of each farm, but no facilities will be provided on the farms by the Molokai project itself.

Tunnel has been constructed to bring water through mountains.

The project is designed to bring under irrigation an area of 13,650 irrigable acres of land which is now dryfarmed, and thereby increase and stabilize the crop yields and the economy of Molokai. It is anticipated that 13,250 acres will be devoted to the production of pineapples, which is already the main crop of the island. An analysis predicts that, with irrigation, the yield will be increased by at least 50 percent and the quality of the fruit will be improved.

The other 400 acres of the project area is expected to be used for growing other fruits, vegetables, and miscellaneous crops. Without irrigation, the production of diversified crops is difficult and the yield is relatively low.

The practice used in irrigating pineapples is somewhat unusual, compared to mainland irrigation practices. A spraying machine is employed (see photograph) and is usually truck mounted, containing a hose reel, pumps, and a long boom, usually 55 feet in length, which allows one-half a block between roads to be irrigated at one time.

Water is supplied to the machine through a hose connected either to the permanently installed distribution system or from an extension of the system consisting of a portable pipe. Application to the fields is by nozzles appropriately spaced on the long boom. Application of water is controlled by the speed of the machine and the pressure on the nozzles. The water is sprayed directly onto the crown of the plants.

Hawaii's Department of Land and Natural Resources is sponsoring agency for the Molokai irrigation project. The Division of Water and Land Development of that department is in direct charge of project construction, operation, and maintenance.

The repayment contract for the Small Projects loan is between the Department of the Interior and the Department of Land and Natural Resources, representing the State of Hawaii. In turn, the State agency will make its own repayment arrangements with the water users.

The water users themselves will be directly represented by two organizations, the State's Department of Hawaiian Home Lands and the Molokai Ranch, Ltd., a corporation.

That portion of the project area represented by Hawaiian Home Lands amounts to about 6,150 acres, in the Hoolehua area, devoted to small tracts of about 35 to 40 acres each, reserved for native Hawaiians.

The remaining 7,500 acres, in the Mauna Loa area, are owned by the Molokai Ranch, Ltd. Interest will be paid on that portion of the Federal loan allocated to serving lands in excess of 160 acres in a single ownership.

This is dam in source area of Waikolu Valley on leeward Molokai.

Unique truck-mounted spraying machine irrigates field of pineapples. (Photos courtesy Hawaii Division of Water and Land Development.)

Full repayment of the loan will be made in 43 years after the completion of construction. During the first 3 years, no payment on the principal of the loan is proposed, although interest will be paid on that portion of the loan allocated to service for the excess lands. Starting with the fourth year, the loan would be repaid in 40 equal installments.

The State of Hawaii entertains no doubt about the important part such projects will play in Hawaii's economic expansion. Governor Quinn has said, on behalf of his State, "We have a great need for small irrigation projects," adding that permitting Hawaii to come within the scope of the Small Reclamation Projects Act will prove most beneficial to the State. # # #

Flaming Gorge Serves as Classroom

In order to study cooperation between private enterprise and government and to give students a chance to observe many different occupations, a faculty committee at the high school in Manila, Utah, last spring turned to the Bureau of Reclamation's Flaming Gorge Unit at Dutch John as their on-the-job classroom for a day.

Flaming Gorge Dam, under construction only 20 miles from Manila, is a major feature of the Bureau's Colorado River storage project.

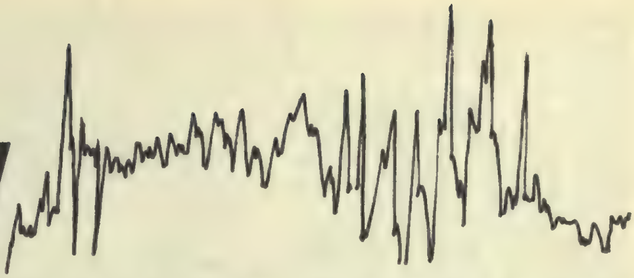
The junior and senior students of Manila High School visited the offices of the Bureau and Arch Dam Constructors, prime contractor for construction of the dam. There they were briefed by George Hensley, Jr., project Administrative Officer, on the mission of the project office, organizational structure, and relationship to other agencies and offices of the Department of the Interior.

The students were then divided into groups of two or three in line with occupational fields they propose to pursue upon completion of their education—i.e., engineering, mechanical, administrative, stenographic, etc. Each group was conducted to the specific branch in the project office responsible for performing the functions of the chosen occupational field, where these functions and the relationship of the branch to the organization as a whole were explained in detail.

Jack Burton, social studies teacher, served as chairman of the school project, working with student leaders to develop the objectives and procedures which provided maximum opportunity for the students to study government and occupations.

The objectives were defined as (1) obtain a general knowledge of economic factors involved in the Flaming Gorge project; (2) develop an appreciation of the cooperation between private business and government; (3) learn as much as possible about the financial support private business and government contribute toward Daggett County (taxes, employment, etc.); (4) develop appreciation of and see the need for higher education; (5) gain an introduction to the various job opportunities; (6) help create a greater interest by students in different occupations; and (7) guide students in gaining an understanding of the importance of productivity and earning a livelihood in our democracy. # # #

Electricity DETECTS CANAL SEEPAGE



Bureau of Reclamation engineers and scientists are experimenting with an electrical method to detect seepage from water-filled irrigation canals.

The technique being tested is called "electrical logging." It is an adaptation of the method developed by petroleum engineers to probe beneath the earth's surface for new sources of oil.

Field trials on Reclamation projects have shown that the electrical properties of the materials comprising the bottom and the banks of a canal have a relationship to seepage. If these materials are wet gravel and sand or wet silt and clay, they will have a lower electrical resistance than when they are dry. Low-resistance zones may indicate seepage.

In addition to resistance, another electrical property of earth materials is their natural electrical voltage. One cause of the natural voltage is the slow movement of water through fine-grained materials.

If the natural voltage in the materials surrounding the canal shows little variation from point to point, tests indicate that the canal is "tight" and that there is little or no loss of water. This interpretation has been verified in logging field tests by seepage meter measurements, ponding tests, and carefully made "in-flow out-flow" measurements at points along the canals studied.

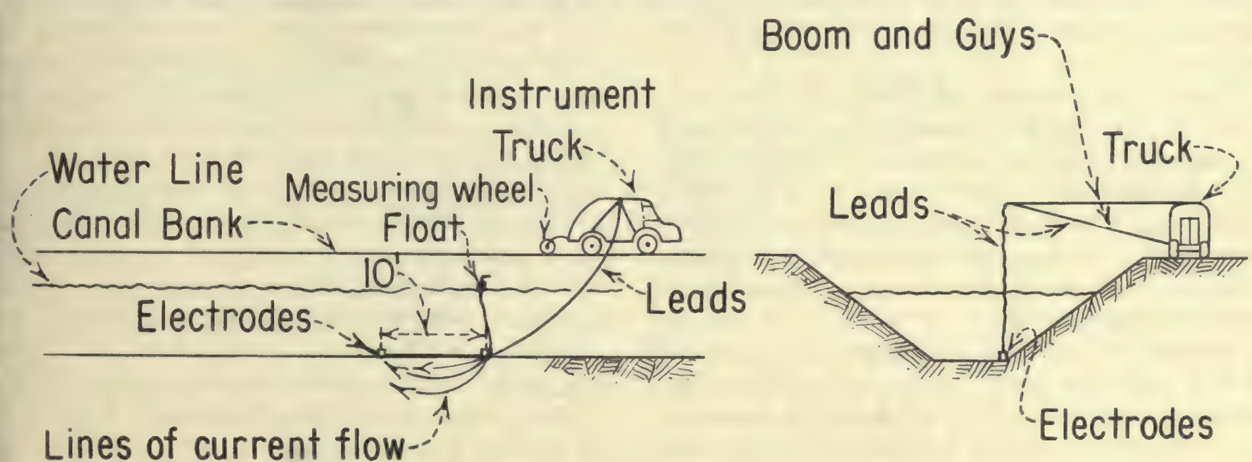
In contrast, if the natural voltage through the canal's surrounding materials changes rapidly at adjacent points along the canal, Bureau tests have shown that such reaches may have appreciable seepage.

The electrical characteristics of resistance and natural voltage of the materials surrounding the canal are shown in the accompanying sample of an electrical canal log which was recorded in Kansas in the fall of 1960. On this log small crosses mark the locations of seepage meter measurements which substantiate the interpretation of the logging method.

Seepage meter losses are expressed in cubic feet

by DART WANTLAND, Geophysicist, and D. L. GOODMAN, Engineer, Office of Assistant Commissioner and Chief Engineer, Bureau of Reclamation, Denver, Colo.

Schematic drawing shows essential elements of electrical logging equipment, (1) viewed from canal bank and (2) cross section of canal.



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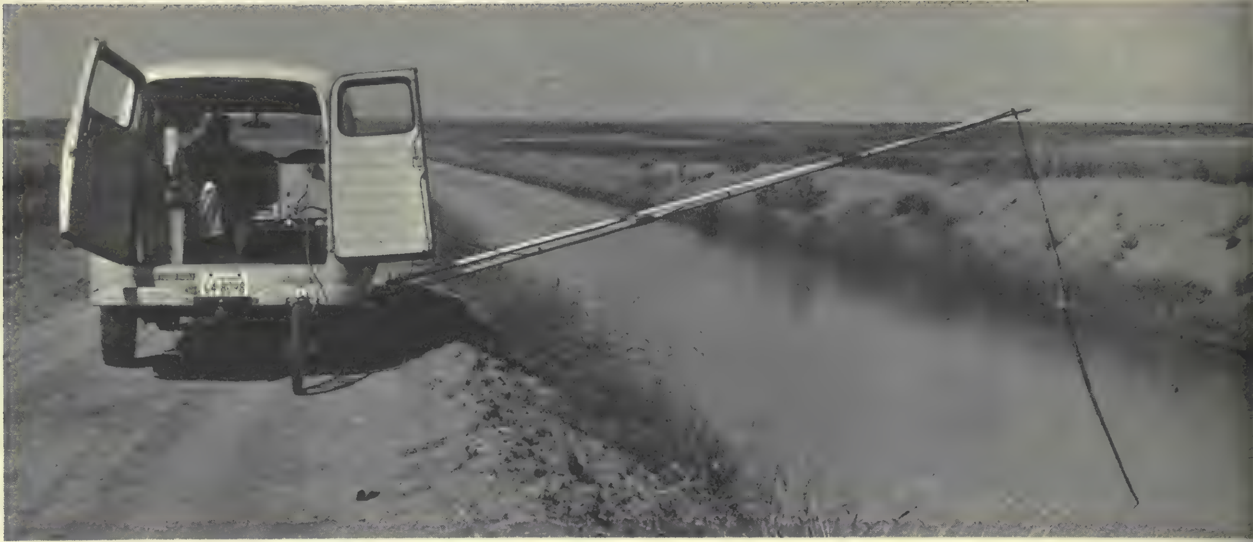


Here Reclamation geophysicists apply electrical logging technique along reach of Kirwin Main Canal, Missouri River Basin project, Kans.

of water for each square foot of the bottom and sides of the canal below water for every 24 hours. By "rule of thumb" a loss of less than 0.5 cubic foot per square foot per 24 hours can usually be tolerated. A loss greater than 0.5 may require remedial measures.

Electrical logging produces a continuous graphical record on a paper strip chart of the resistance and natural voltage of the rocks and formations below and around the canal. The electrical log tells a story of conditions below the surface, because different beds vary as to their electrical properties.

To log a canal, two lead weights, called electrodes, are connected by waterproof wire to a source of electric current and to measuring and recording equipment in a logging truck riding along the canal bank. The truck is equipped with a boom which permits the electrodes to be dragged along the bottom of the canal as the truck travels on the canal bank.

These arrangements are shown in the accompanying drawing and photograph. As electricity is passed through the electrodes, a picture of the differences in the various layers of the ground is traced by two moving pens of a chart recorder in the truck. One pen records changes in resistance and the other records variations in voltage of the surrounding materials.

Reaches of canal can be logged at a speed of 2 to 3 miles per hour. The spacing of the electrodes controls the depth to which the resistance and natural voltage of formations is measured. In most of the Bureau's field tests, a 10-foot spacing of the electrodes was used.

To identify a point on a canal where a structure, such as a farm turnout, is located with the equivalent point on the log, a scale of distance is established on the log itself.

This is possible because the chart recorder is driven by a fifth wheel which trails behind the logging truck. This wheel is connected to the chart drive by a speedometer cable and a gear train so arranged that 1 inch on the chart equals 100 feet of forward movement of the instrument truck.

The different structures passed along the canal during logging can be noted on the log and their distances apart checked. A float attached by a cord to the leading electrode marks the position of that electrode.

Bureau engineers emphasize that the electrical logging as applied in canals to determine seepage is in an experimental phase. For this reason, in planning field tests every effort is made to locate canals where there is a considerable amount of detailed information on seepage conditions. Electrical logs of such canals can be compared directly with known seepage conditions and/or tightness.

The use of electrical logging to detect seepage from canals was first investigated by the Bureau in 1958. The initial field test was performed under a contract with the firm of Turner & Associates, consulting geologists and geophysicists, of Phoenix, Ariz. Four reaches of canals on the Central Valley project, California, which covered about 7 miles of canals, were logged.

The second field trial of electrical canal logging was also made in California, in April 1960, by Bureau engineers using a surplus drill hole logger obtained from the U.S. Atomic Energy Commission. In addition to measuring resistance, the measurement of natural voltage was found to be possible.

Three subsequent field tests by the Bureau, in Kansas in 1960 and in New Mexico and Montana in 1961, have broadened understanding of the method and knowledge of its limitations. All field tests and further studies which are planned have been undertaken as part of the Bureau's lower-cost canal lining and soil and moisture conservation programs.

For the irrigation farmer and the operators of irrigation projects, the electrical logging of canals to detect and locate seepage has potential importance for three reasons:

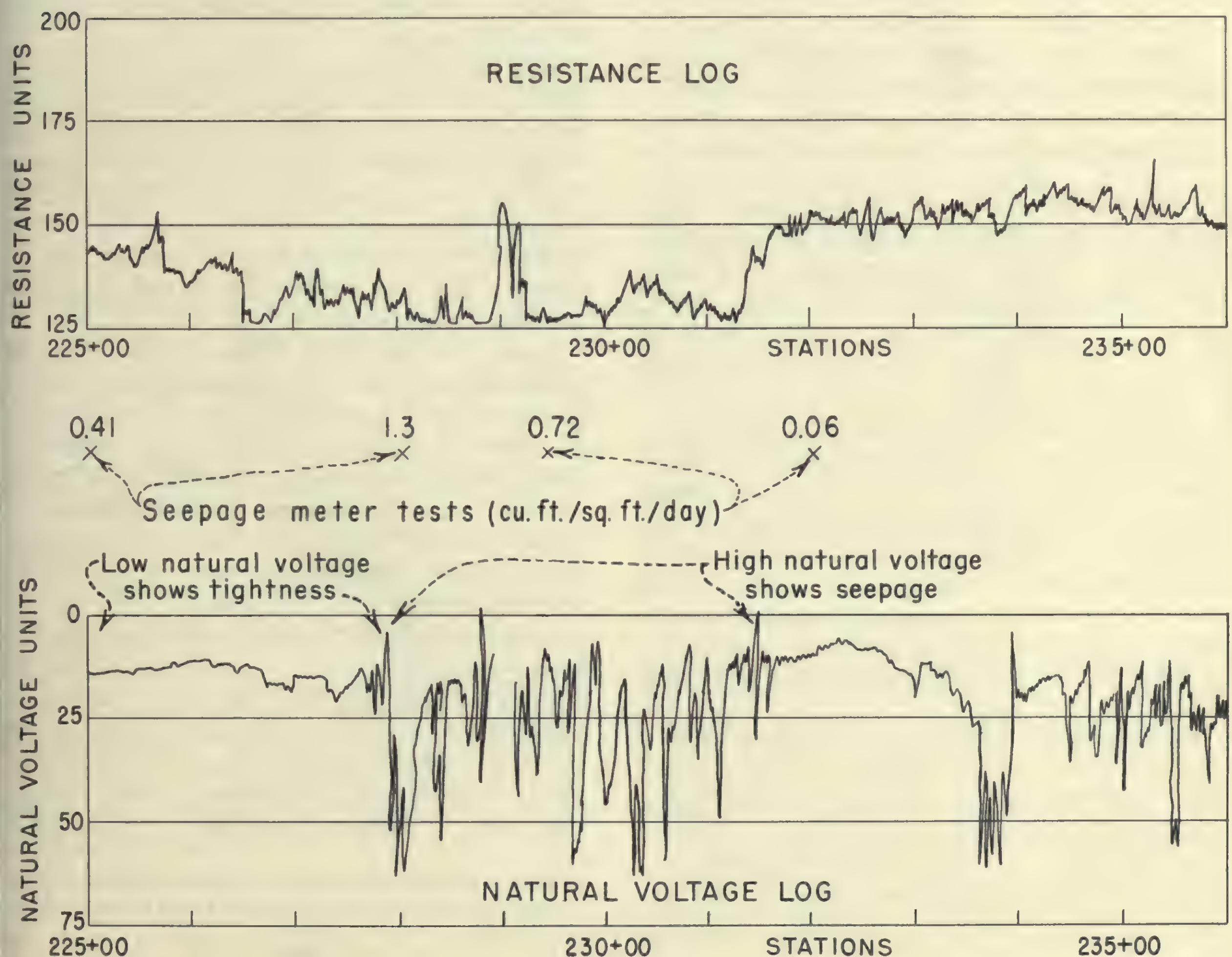
1. Electrical canal logging may be able to determine, approximately, leaky reaches of canals and distinguish them from tight reaches so that repair, lining, and other maintenance work can be confined to the portions of a canal or canal system that are in poor condition.

2. Electrical canal logging can function in both lined and unlined canals, and when fully developed, the method may provide an appraisal of leakage along a major canal without requiring that the canal be taken out of service.

3. Electrical canal logging may be able to locate leakage zones as well as tight sections of canals at less cost and in much less time than by other means presently available, such as ponding, seepage meter, and in-flow and out-flow measurements. At the rate of 2 miles per hour, 16 miles of canal can be logged in an 8-hour day.

# # #

Electrical log charts a running picture of potential seepage in canal, as shown below. Canal stations are 100 feet apart.



Dried Fruit Production

California's "badlands" of Gold Rush days have become some of the most productive agricultural lands in the world—with the addition of irrigation. This irrigation, combining with a sunny climate and rich soil, today supports a vast fruit growing and processing industry. Bureau of Reclamation water storage and distribution facilities—in the Central Valley and in southern California—furnish an important portion of the necessary water.

In these days when such a large part of the fruits and vegetables we consume are preserved in cans or by deep-freeze processes, it is sometimes hard to realize that man's oldest known method of preserving and storing Nature's bounty—drying in the sun—is still playing a major part in our lives.

California alone produced and packed over $162 million worth of dried fruits in 1960. With almost a million acres of irrigated fruit farms, its mild frost-free climate, and its warm sunny days through most of the year, it has truly become a fruit basket to the Nation. This is particularly true of the dried-fruit industry, for nowhere else in the United States, with the possible exception of Arizona, are the climatic conditions so ideal for the drying of fruit.

As a result, in 1960 California farmers devoted almost 220,000 acres to the raising of fruit for the dried-fruit packing plants, and produced about 400,000 tons of dried fruit with a farm value of about $115 million. About 82 percent of this production and income came from dried prunes and raisins having a value of about $96 million, and the balance was divided among dried apricots, apples, figs, dates, peaches, and pears.

The traveler riding through the great Central Valley of California in August and September is struck by the miles and miles of vines, with raisins on wooden trays or heavy paper lying between the rows drying in the sun. One-fifth of all grapes raised in California in 1960 were made into raisins, which returned the farmers and packers almost $57 million.

Scattered throughout the valley are tremendous peach orchards and among them, every so often, one sees acres of freestone peaches cut in half and lying on trays while the sun dehydrates them after they have been fumigated with sulfur fumes in the gastight sheds used for this purpose. About $2,450,000 was received by the farmers and the drying yards and packers of California in 1960 for these dried peaches.

Spring in the Santa Clara Valley with its thousands of acres of prune and apricot trees in bloom is a memory few travelers will ever forget. Over 50 percent of the dried prunes from California are raised in Santa Clara County. Sutter, Sonoma, Napa, and Colusa Counties account for almost another 30 percent. Dried prunes alone returned $75 million to the farmers and to the packers in 1960.

Almost a third of California's apricots also come from Santa Clara County, which with San Benito, Conta Costa, Salinas, and Stanislaus Counties, is among the five leading producers of this crop in the State. With returns to farmers of over $759 a ton, apricots dried in California in 1960 brought them about $7,300,000 to which the drying yards

by ALEX G. NORDHOLM, Repayment Specialist, Bureau of Reclamation, Fresno Field Division of Central Valley Operations Office, Fresno, Calif.

Figs are placed on trays in the sun to dry to about 16 percent moisture near Merced, Calif. (Photo courtesy California Fig Institute.)

and packers added another $1,776,000 to the value of these crops.

Fig growing in the full commercial sense, after many attempts that failed or were only partially successful because of unsuitable soil or climatic conditions, finally centered itself largely in the Central Valley counties of Fresno and Merced which raise 93 percent of California's and the Nation's figs that were dried. The farmers received almost $4 million for the 17,200 tons produced and declared marketable in 1960.

The Central Valley, sheltered from the cooling winds of the coastal regions by the Coast Range and protected on its eastern border by the mighty Sierra Nevada, offers ideal soil and climatic conditions during the long, rainless summers which allow the figs to grow and mature to a perfection not attained in any other part of the Nation.

The fruit that is dried is left on the trees until fully ripe and partially dried from the sun, at which time it falls to the ground or is shaken off and gathered in boxes. In the dry lots the figs are fumigated, placed in trays in the sun to further dry to about 16 percent moisture, or they are rolled on trays into a dehydrator where hot air is circulated through them for about 12 hours as they pass through. Then they are sorted and inspected for quality.

The figs are then delivered to the packing plant where they are weighed, sampled, and further tested for quality. Those accepted are sorted by mechanized screen graders to size, prewashed, cooked in boiling water or softened in retorts by steam under pressure.

Afterwards they are packed into bricks and fancy packs, or sliced and ground into fig paste, and placed in containers to be shipped for use in cookie making. The dry lots and packers added another $4 million to the value of the California dried figs shipped in 1960.

California's dates are all raised in the desert area around Palm Springs, Indio, and Coachella in Riverside County. Irrigated by wells and with water from the Coachella Reclamation project, the stately palm trees stand with their feet in the water and their heads in the sun.

The long, straight rows of tall trees with their fronds reaching out toward each other resemble the arches of a medieval cathedral, and the shade and subdued sunlight sifting in through the trees heighten this cathedral quality of the date groves.

Here, on 4,000 acres of date groves, the farmers raised a crop which brought them about $2,700,000 in 1960 and the local packinghouses added a like amount to the value of the crop before it was shipped to the Nation's markets.

Although the State of Washington raises twice as many apples as California, the latter dried over 2 million bushels of apples in a recent year as against 1.6 million bushels from Washington. The only other State producing dried applies is New York, and that year it dried only 75,000 bushels.

Economic Impact on California

Quite naturally, the income to California farmers of about $115 million from dried fruit and the subsequent income of over $47 million to the packing and processing plants who prepared the fruit for market affects the livelihood of a great many persons in the State.

Irrigated fruit farming in California is an intensive and highly specialized type of farming. Although there are many large vineyards and fruit farms in the Central Valley, the characteristic

fruit farm in California is usually a family enterprise of not more than 40 acres.

On this basis, it can be assumed that from 5,000 to 6,000 farm families derive a large part of their income and support from owning and operating these farms which produce the fruit that is dried. In addition, many of the farms provide year-round employment for a hired hand and seasonal employment in pruning and spraying the vines and trees and harvesting the fruit for thousands of farmworkers.

But beyond the incomes earned by farm families and seasonal farm labor, there is the considerable employment of year-round permanent help and seasonal workers in the drying yards and plants where the dried fruits are processed and packaged. Employment in the dried prune packing plants in California in 1960 varied from a minimum of 1,300 persons in June to a maximum of 3,164 persons in October.

In the raisin packing plants, the cost of labor varies considerably as it does in the other dried fruit packing plants, depending on the variety of fruit and the degree of mechanization in those plants, but a range of from 35 to 40 percent of the value added in packing seems indicated for labor cost in processing raisins.

Woman picker places grapes on tray in a Fresno County vineyard. Fruit will go to packing plant next for processing into raisins.

This would represent total payable in 1960 of from \$5,686,000 to \$6,464,000 in the raisin packing plants alone. These raisin packing plants employ in the neighborhood of 1,000 year-round salaried and hourly paid production and maintenance personnel. During the 5 or 6 months of the most active packing season, the employment in these plants about doubles.

Packing Raisins

Raisins are delivered to the packing plant, by the growers or their truckers, in large boxes known as "sweat boxes," each of which contains about 110 pounds of field dried raisins.

As the shipment comes into the plant, it is unloaded onto the dock, usually by mechanized forklifts, and then taken to a temporary storage space. Here, samples of each grower's lot are taken and inspected by the U.S. Department of Agriculture trained inspectors for moisture and sugar content, as well as quality and cleanliness.

The contents of the boxes are then emptied onto moving conveyors to start their journey through the plant. Many of the raisins are still in clusters at this stage. The conveyors are built to gently toss and shake the clusters to separate the raisins from their stems as they move along.

Powerful airblasts from under the conveyor belt blow the dust and stems away, and the undersized raisins drop through the screens on which the raisins travel and are carried on conveyors to cull bins.

The raisins then pass under jets of water which thoroughly wash them before they get their final inspection. This inspection is done by women who stand on either side of the conveyor and carefully remove any little stems that may be still among the raisins and any small raisins which may have escaped the wire screens. Some plants have developed special stemming machines which insure that no stems adhere to the fruit as it is packed.

The raisins are then carried by conveyors to hoppers and packed in two principal ways. Those which are destined for the bakery trade are placed in 30-pound packages which are weighed and sealed by automatic machines. The packers and inspectors weigh the boxes carefully to insure

the proper amount in each.

Other raisins are packed in smaller cardboard boxes or cellophane bags for the grocery trade. Here, automatic weighers and sealers are used in some plants, and in others the weighing is done by inspectors who then close the boxes and seal them.

They are then placed in corrugated cartons of various sizes, which are sealed and carried by conveyors to the shipping room for final delivery to the railroad cars and trucks which will carry them to market.

Local Effect of Raisin Packing

An analysis of just one large operation will serve to illustrate what this raisin packing activity can mean to a community. Take, for instance, a plant which originally cost over $3,500,000 to build and equip. (Today the cost would be almost double.)

At least a third of this plant cost went to labor in wages paid to bricklayers, carpenters, electricians, and other construction workers in the community.

In one recent year this plant provided over 1 million hours of employment, representing about $2 million in wages. This in turn meant much to the local merchants, doctors, and others.

The plant purchases thousands of tons of cartons, cardboard boxes, and packing materials. Over $2 million is spent annually in the local community for these, and additional thousands for plant and office supplies. The manufacture of these supplies employs additional hundreds of persons.

The city and county in which the plant is located received about $175,000 in taxes in a typical year to help run the schools and other municipal services, and almost as much as this was paid in payroll and other miscellaneous taxes.

Freight rates on raisins shipped to the rest of the United States vary from $2 to $3 per hundredweight depending on the ultimate destination. Using an average freight rate of $2.50 per hundredweight, the railroads of the Nation received $3,750,000 from shipments of this plant alone and employed a considerable number of trainmen and engineers and maintenance crews, etc., to furnish this service.

And last, but certainly not least where the rest of the Nation is concerned, the purchasing power created by this fruit-processing industry pays for automobiles, furniture, appliances, apparel, and machinery shipped into California. Thus, California is not only a fruit basket to the rest of the Nation but a market for its industrial products as well.

# # #

Raisins are washed by jets of water as they move along on conveyor belt. (Latter two photos courtesy Calif. Raisin Advisory Board.)

THEN and NOW-

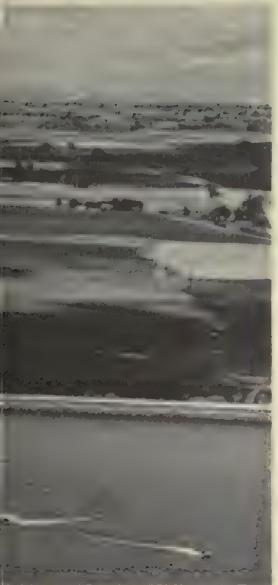
Reclamation's Story

There are few better examples anywhere in the entire West of the multiple benefits which flow from irrigation development than the highly successful Boise Reclamation project in southwestern Idaho.

Actually, irrigated farming in the Boise Valley antedates the 60-year-old Federal Reclamation Act by nearly 40 years, because the first right to divert water from the Boise River for irrigation was granted away back in 1864. This early water right covered the irrigation of the townsite and also supplied the Army's Fort Boise.

Fairly large-scale irrigation got underway during the early 1880's and by the time the Federal

Please turn to page 72



Top row of photos: Graders such as the one at left were among early machinery used in construction of storage works on Boise project. The results include Lake Lowell (Deer Flat Reservoir), center, shown here with Nampa Canal snaking out from it. Returning to bygone days, photo at right, taken in 1907, shows Reclamation train returning from embankment on Boise project.

Middle row: At left is modern view of main street in Star, Idaho, while at right is the same street around a half century ago. Development of water resources not only has helped the farmers, but is also a basis for progress in the communities that serve them.

Bottom row: At left is aerial view of a section of New York Canal, running through neat green countryside on Boise project. At right is a different section of the same canal, showing headgate, as it looked a half century ago.

Reclamation Act was a matter of law, about 148,000 acres were already under ditch in the Boise Valley.

However, as President Theodore Roosevelt said, when advocating passage of the Reclamation Act of 1902: "Great storage works are necessary to equalize the flow of streams and to save the floodwaters. Their construction has been conclusively shown to be an undertaking too vast for private effort. . . . It is as right for the National Government to make the streams and rivers of the arid region useful by engineering works for water storage as to make useful the rivers and harbors of the humid region by engineering works of another kind."

The President was speaking of development of water throughout the arid reaches of the West, but, of course, his concern with storage of water, and not merely diversion of riverflow, was as pertinent to the Boise Valley as to any other area.

Today's visitor to the Boise Valley cannot help being impressed by the marked contrast between vast desert reaches and green fields below the irrigation canals. This contrast illustrates decisively that irrigation is the backbone support of the area.

The first Federal authorization to supplement the already existing development came about in 1905. Since the initial step, the project has grown considerably and now contains some 350,000 acres.

Over the years, five storage dams, with a combind total storage capacity in their reservoirs of nearly 1.7 million acre-feet, have been constructed. Two diversion dams have been added, as well as three powerplants with a combined generating capacity of 36,500 kilowatts. The distribution systems include over 344 miles of canals, nearly 1,200 miles of laterals, and about 400 miles of drains. Seven pumping plants are located at various points throughout the project.

On modern Idaho farm, onions are being harvested for ready market.

Besides primary purposes of irrigation and power production, the Boise Reclamation project serves in numerous other direct and indirect ways to make the Boise Valley a desirable place to live.

The storage reservoirs are operated on a system forecast basis to provide a maximum amount of important flood control.

The cultivated fields are havens for an increasing upland game bird population, and the many flyways provide rest stops for migratory birds using the Pacific flyway as they move south each year. One area of Lake Lowell, a major off-stream storage reservoir, is set aside as a wildlife refuge.

In keeping with the times, recreational use of project reservoirs continues to expand each year.

All in all, the Boise Reclamation project is a living justification of the faith that Theodore Roosevelt and other early reclamationists had in national growth through water resource development. # # #

Below are wheat threshers from an earlier day. Irrigation has given farmers chance to diversify today to crops in greater market demand.

Drainage in Irrigation - a world problem

by C. R. MAIERHOFER,
Chief, Bureau of Reclamation's
Office of Drainage and Groundwater
Engineering, Denver, Colo.

Part I

Drainage—or the need for it—has been the nefarious companion of irrigation wherever irrigation has been practiced. This means that drainage problems are global problems, and it means that man has had them since the day he ventured from his humid environment and learned he could feed himself in the desert if he brought water to a plant.

At the other end of the string of time, in our constant search for more knowledge of the plant-soil-water complex, we find drainage problems as new as the next shot at the moon.

The role played through the centuries by irrigation is dramatic—and always drainage has been the villain. Many times through history, flowing waters have developed the same pattern in different parts of the world. Even though early history is sketchily recorded, we do have plenty of evidence that those desert civilizations of antiquity that played the overture for the irrigation theme progressed or declined in relation to the severity of their drainage problems.

We know that mighty nations failed completely and that others just managed through the centuries to squeeze a bare existence out of waterlogged and salinized soils as their cultures sagged to primitive levels. A few, treated kindly by Nature, did not develop drainage problems. A very few finally learned the cures for waterlogged and salinized soils and prospered.

No one knows for sure when man began to irrigate, but the idea must have sparked in his brain when he was able to comprehend that Nature was irrigating when she annually flooded dry lands along a river. This provided food and the way Nature did it, there was no drainage problems.

Then, in the muddled process of man's intellectual development, one fellow conceived the aggressive notion that water could be stored or raised by a diversion dam and used when there was no flood, or even taken to higher ground. He tried, and it worked. This prelude to irrigation developed into a big and fattening thing for hungry millions. Irrigation is still developing and expanding, and while some of the world's millions are still hungry, many other millions are better fed.

When he learned to store water and to build diversion dams, the prehistoric forebear of today's irrigators also had to build canals to take the water from the pond or river to the land. As today, these canals leaked. As today, this fellow reasoned that if some water was good, more would surely be better, so he let his canals run and more water went into the ground than the plants could use or the natural subsurface drainage of the flat desert could carry away. He upset Nature's balance and generated himself a drainage problem.

About the Author

Mr. Maierhofer has worked on drainage problems in the 17 contiguous Western States, and, in addition, he has been loaned by the Bureau of Reclamation as a consultant to Canada and Puerto Rico and to the State Department and the United Nations for assignments in countries in the Middle East and Mediterranean areas and the Indian subcontinent. He is a registered professional engineer and has been chairman of the Committees on Drainage of Irrigated Land of the American Society of Civil Engineers and of the American Society of Agricultural Engineers, as well as chairman of the U.S. National Committee of the International Commission on Irrigation and Drainage.

As he continued to irrigate without draining, the substrata of his lands became a reservoir, and the water rose in the soil until it was so close to the surface that plants could not grow. Then, if he had the stores and strength to move, he gathered his camels and his women and migrated to other lands, there to perpetuate the age-old land-use cycle of waterlogging-salinizing-abandoning.

Today, as one streaks in a jet at 20,000 feet over the deserts of Asia, Africa, Europe, and the southwestern United States, he can read the epitaphs of small villages and mighty population centers in the sandcut remains of cottages and palaces and prehistoric irrigation works.

On the hot and desolate ground he can see where the lands are salty and why the people either moved elsewhere or starved to death.

Although the early records of Assyria, Babylonia, Egypt, Persia, India, and China refer to ancient practices of irrigation, the record of drainage is harder to find. We think the farmers of ancient Egypt built surface drains on their wet lands so they would yield more and better grain.

Some people believe that the Hanging Gardens of Babylon were an escape from rising ground water and that the Tower of Babel in the Plain of Shinar fell because the ground water has risen into its foundations, rather than amid the mad babel of a confusion of tongues.

Speculation or fact, these places could support life only when they were irrigated. We can see that they developed drainage problems, and bad ones, because the people are gone, the ruins are there, and the lands are severely salted. We see the same story today—lands irrigated, then waterlogged, then salinized, and then either abandoned or drained.

There are written records of irrigation from storage or diversion dams in Babylonia more than 4,200 years ago, and there is substantial evidence that it was practiced at least 1,200 years before that by King Menes, the first Pharaoh of the First Egyptian Dynasty.

The system of basin irrigation which Menes introduced along the Nile is still being used there in today's agriculture. Babylonian irrigation needed drainage, did not get it, and failed. The early Egyptian irrigation needed little or no drainage, so succeeded. The lesson is there for all to learn—and heed.

King Hamurabi of Babylonia, in the valleys of the Tigris and Euphrates Rivers of old Mesopotamia, apparently had ditch riders about 2300 B.C. because the record shows that he enforced codes for controlling the flow of water from irrigation canals to fields.

Queen Semiramis followed old Hamurabi about 300 years later. Not wishing to be forgotten as a pioneer in irrigation development, and to assure that she would be remembered as one of our earliest female engineers, this lady extolled her role for posterity.

The eulogy on her tomb includes this language: "I constrained the mighty river to flow according to my will and led its water to fertilize lands that had been barren and without inhabitants." Considering the size of the Euphrates at Babylon, this was quite a trick.

The feat also makes one wonder what Hamurabi did and whether the queen bungled his accomplishments. Whatever transpired, much of this land is today again without inhabitants, and its salt shows that it was once waterlogged.

India claims to have sung the lullaby at the

Ruins such as this remain on the once-irrigated plains of Asia. When drainage was lacking, soils became salted and civilizations declined.

cradle of irrigation practice. The oldest references to dams, canals, wells, and tanks are in the Vedas, the earliest sacred books of the Aryans. The Aryans absorbed the aborigines of India and were the first to emerge into the light of civilized pursuits, such as irrigation—even without drainage.

One of these books describes "the digging of canals and taking off of rivers." For those less literate, the idea was illustrated by the river being a cow and the canal a calf feeding from her.

Another Veda tells that dedication ceremonies are not a recent exercise for calling attention to new irrigation projects. A translator gives us this interesting bit about bringing the first water to thirsty acres: "A gold plate was laid at the mouth of the canal on which a frog tied with blue and red threads was made to sit. The frog was then covered with moss and water was let in."

Perhaps the frog and moss were symbolic of more meat and greens to come; but, surely, we can presume the gold plate symbolized the resultant increase in the local economy to be brought about by irrigation.

There may come some argument on who practiced irrigation first, depending on individual beliefs about man's origin. Most of us in this part of the world know that Genesis 2: 10 says: "A river went out of Eden to water the garden and from thence it was parted, and became into four heads."

Since no one knows for sure where Eden was nor just where the Aryans joined the human cavalcade, the earliest writers may actually have been referring to the same projects, and the canals with the frogs were likely the same in everybody's book.

We know that these early irrigators were not

These two scenes in Afganistan show soil damage. First there is salt in water, then in soil—as crusts grow thicker in desert heat.

Primitive farming methods continue in many parts of the world. Task will be to bring these methods into line with modern irrigation.

without drainage problems. The first written evidence we have of the drainage problem was again in the valleys of the Tigris and Euphrates Rivers of Babylonia.

The 2300 B.C. Code of Hamurabi, the same fellow who had ditchriders, provided: "If anyone opens his irrigation canals to let in water, but is careless and the water floods the field of his neighbor, he shall measure out grain to the latter in proportion to the yield of the neighboring field." This was surface drainage, but nevertheless one of the same beginnings of severe drainage problems we have today.

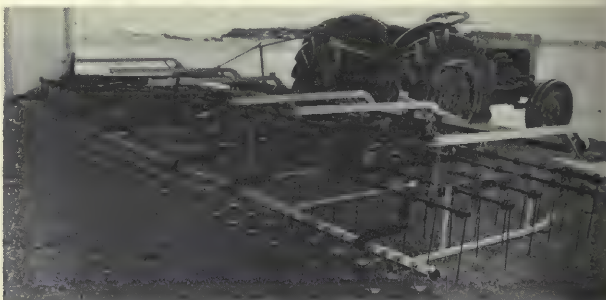
The first written record of a successful engineering solution of drainage problems came from Cato, who wrote extensively in 200 B.C. on the subsurface drainage practiced along the Mediterranean during his time. The farmers simply dug ditches through the wet spots and put brush, sticks, and stones in the bottom, covered them with dirt, and farmed all the land. This was almost modern drainage.

The tile pipes installed by the ancient Babylonians, which some writers refer to as drains, were to carry off sewage. For drainage of their excess irrigation water, the Babylonians apparently preferred to hang their gardens and let them drip-dry. # # #

(Part II in the November *Era* will deal with drainage problems and solutions in modern times, concluding this article.)

MECHANICAL BEET THINNING

by YALE HOLLAND
The Amalgamated Sugar Co., Nampa, Idaho



One of the most progressive steps in the mechanization of sugarbeet cultivation was the development and application of the flex harrow as a high-volume weed control tool which eliminates the weaker beets and provides some stand reduction in sugarbeets. However, it has taken the development of a new attachment to the harrow to practically revolutionize the work involved in stand reduction.

Both the harrow and the attachment had their initiation in the high-yielding beet fields of the Boise Valley of Idaho. The harrow was popular from the first, but its use as a universal beet tool was limited because it could not be relied upon for complete and final stand reduction. The recognition of this led to the development of a tool which could be attached to the rear of any flex harrow section to provide the long awaited once-over stand reduction.

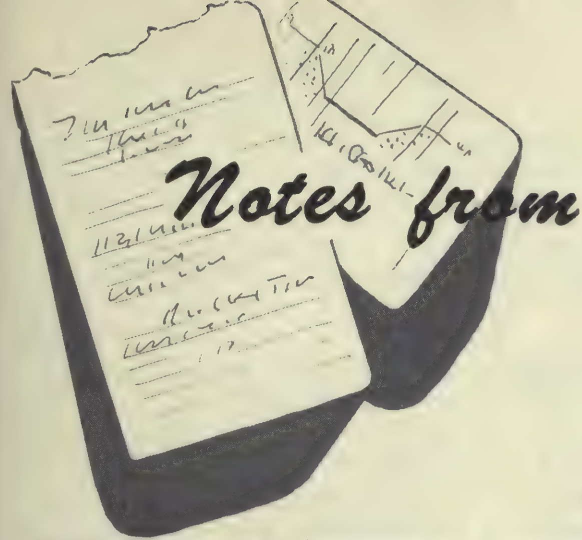
This attachment makes use of casehardened 3-inch mower sections riveted to spring steel shanks which are clamped on a single bar in such a way that when used as a sort of glorified cross blocker, a precision cut can be made leaving any desired uncut block containing mostly single beets.

After a year's trial, the machine performed beyond expectations. When attached to the grower's flex harrow, this tool allows a 25–35-foot sweep at right angles across a field. It is possible for one operator to reduce a stand to any desired proportions at the rate of 10 acres per hour, formerly the work of over 100 men.

But no matter how faultlessly a machine performs, some remaining irregular stands only emphasize the truth of the old adage which applies to man or machine: "If you want single beets, you must plant only single beets." Too many clumps were being left, even in the narrow uncut blocks neatly left by the cutter.

To remedy this, many Boise Valley beet growers—after sugar company winter educational meetings—have checked, adjusted, and calibrated their drills to insure accurate plainting of the new pelleted monogerm seed. Now, for the first time, single germ seeds can be accurately spaced at a safe 2 to 3 inches apart on soil fall bedded for uniform germination moisture.

After the danger of early frosts and after customary flex harrowing for weed control, the grower can rely on his cutter attachment to reduce his stand to any desired degree, and the remaining beets will likely be healthy and weed-free singles demanding at the worst only a perfunctory long-hoe trim. # # #



Irrigation Operators' Workshop

Part III

Water measurement procedures on irrigated farms and methods to achieve more efficient use of water were among the principal topics discussed by the 82 participants from the 11 Northern States of the Reclamation West in the Irrigation Operators' Workshop held in Denver the week of December 11–15, 1961.

Discussion leaders, all of the Bureau of Reclamation were: Winston H. Hedges, Chief, Irrigation Operations Division, Kansas River Project Office, McCook, Nebr.; Edgar H. Neal, irrigation supervisor, Columbia Basin Project, Ephrata, Wash.; Glen H. Simmons, Chief, River Control and Storage Division, Minidoka Project, Burley, Idaho; and Alvin J. Peterka, Head, Hydraulic Investigations Section, Division of Engineering Laboratories, Denver.

In the discussions on water measurement, it was emphasized that more extensive use of the available water from an irrigation project can be made if all measuring devices are accurate and dependable. Every cubic foot of water saved as a result of improving the accuracy of measuring devices is more valuable than a similar amount obtained from a new source, because the saved water is produced at considerably less cost.

Virtually all measuring devices which are in error deliver more water than they indicate, and it is important that each water user know exactly how much water he is receiving. If he thinks he is receiving 5 cubic feet per second and is actually getting 6 cubic feet per second, he will be seriously hurt if at some future date he actually receives 5 cubic feet per second under a water-rationing plan. It is often only necessary to understand the factors which influence measurement accuracy and make minor modifications to transform an inaccurate device into an accurate one.

On some older irrigation systems, these are some of the problems that may be encountered: Staff gages are worn and difficult to read. Stilling-well intakes are buried in sediment or partly blocked by weeds or debris. Parshall flumes are frost heaved and out of level. Meter gates are partly clogged with sand or debris and the gate leaves are cracked and worn.

These and other forms of deterioration cause serious errors in discharge measurements. It is imperative, therefore, that the person responsible for the measuring devices inspect them with a critical eye. His attitude should be: I am looking for trouble—not, I will excuse the little things because they are not worse today than they were yesterday.

Repairing or refurbishing a rundown measuring device is sometimes a difficult task. Making minor adjustments as they are needed will usually prevent having to replace the entire device at great cost at some later date. Regular and preventive maintenance will extend the useful life of measuring devices.

Every water-measuring device has limitations, and it is impossible to choose one device which can be used in all locations under all possible conditions.

If flow conditions change or are changed by modified operations, an original device, which was marginal in suitability, may be found to be totally inadequate. It is possible, too, that the wrong device was selected in the first place.

Whatever the reason, there are instances where accurate measurements are being attempted using a device that cannot, even with the greatest care, give the desired results. The operator should call attention to such a situation and attempt to have remedial measures taken.

For example, a weir cannot be expected to be accurate if the head is appreciably less than 0.2 foot, or greater than about one-third of the length of the weir blade. Measurement errors can be expected if these limits are exceeded.

If a weir is submerged by backwater, large errors may be introduced, depending on other factors. Submerged weirs should be avoided whereever possible.

It is difficult to establish definite rules which apply generally to water measurement procedures and equipment. Similarly, one measurement device cannot be recommended over any other device until all variables at the particular installation site are considered.

It is therefore necessary for each operator to learn as much as possible about the device he is using and to evaluate the effect of each variable, at the particular site, on the measurement he is making.

Each operator must learn to look objectively at his equipment and procedures. He must be able to see that his equipment is run down and in need of maintenance, or that his measurement procedures are not compatible with what he is trying to measure. He should try to find fault with his equipment and with every step he uses to make a discharge measurement, and try to improve wherever possible.

This means that he must understand the basic measurement he is trying to make and then modify, if necessary, his methods of obtaining it. He should read available literature as much as possible for background information on water measurement. He will thereby not only obtain more meaningful information, but will also have the satisfaction of knowing his measurements are more accurate.

In considering the broad aspects of water management, the delivery of water in the quantity needed, at the time needed, at a cost the user can afford, is the prime function of any operating organization. The modified demand delivery is highly desirable and is of great benefit to the water user in enabling him to irrigate with greatest efficiency of labor and water use.

This weir is operating under good flow conditions in approach pool. Flow is distributed across wide pool and accurate discharges can be expected. Inset shows contrasting conditions, where weeds and sediment in approach pool result in inaccurate discharge determinations.

Efficient management of water delivery is essential on irrigation systems such as Yakima project, Washington. Above is Sunnyside Canal.

This type of water delivery can be described as delivery of a stream or irrigation head when requested by the farmer; the delivery may be modified as necessary when demand exceeds capacity to deliver.

A siphon is being started on Eden project, Wyo. Operator should try to improve water measurement procedures wherever possible.

The modified demand water delivery has many advantages. It is particularly valuable in permitting the water user to "bunch up" his irrigation and then have free time for other farm activities. In addition, the method makes it possible for the irrigation system to meet the high water use period when days are hot and evapotranspiration is at a maximum. The method promotes more efficient use of labor and water on the farm.

The importance of efficient budgeting and planning of project operation and maintenance activities was emphasized by Robert M. Fagerberg, project manager, Shoshone and Heart Mountain Irrigation Districts of Powell, Wyo., when he addressed the workshop participants at a dinner meeting.

Mr. Fagerberg said: "Today, the efficient and financially sound farmer has to find ways to increase the work accomplished on an hourly basis; he must increase the per-acre production; he must find ways of reducing wasted time and reducing production costs; and he must find a sound financial plan for the long-range program of meeting present and future needs. To some extent, a sound operation and maintenance budget and a well-planned program can overcome inflationary rise in costs by producing more units of work under a well-organized plan." # # #

(This is the third article in a series of four. Part IV in the November issue will deal with weed control.)

FACE LIFTING on the NORTH PLATTE

by CHARLES H. RADER, Construction Engineer, Bureau of Reclamation, Torrington, Wyo.

Increasing demands for irrigation water, together with a diminished supply, presents a problem of vital concern in the North Platte project area of eastern Wyoming and western Nebraska.

Two major facets of the problem are:

1. Water supply records indicate the average runoff in the North Platte River watershed has been appreciably less during the past 30 years than during the preceding 30-year period.

2. Only a portion of the water delivered into the irrigation distribution system in the North Platte Valley reaches the land to be irrigated, with up to two-thirds lost along the way, primarily to seepage.

Obviously the solution to the problem of making supply meet future demand lies in correcting, insofar as possible, the loss of water from canals and laterals.

When adequate steps are taken to prevent this seepage loss, much valuable irrigation water can

Workmen are coating end of 24-inch precast concrete pipe with cement slurry and are forming reinforced bands around joints in trench.

be saved. Furthermore, not only water is saved, but good cropland, too. Seepage losses occurring in the canals and laterals cause lands to be waterlogged, and, as a result, lost for crop production. Also, these seeped lands invite unsightly and often costly-to-control weeds and result in irregular-shaped farm tracts.

A boon to older irrigation projects, which now need to bring recently developed improvements to their distribution systems to make them function more efficiently, is the Rehabilitation and Betterment Act of 1949.

It is under this act that the Goshen Irrigation District in eastern Wyoming and the Gering-Fort Laramie Irrigation District in western Nebraska (both on the North Platte project) are making use of modern techniques to improve their canals.

The North Platte project—one of the oldest Federal Reclamation projects—is made up of three divisions, one of which is the Fort Laramie Division. The water users in this division are represented in Wyoming by the Goshen District and in Nebraska by the Gering-Fort Laramie District. These districts are responsible for operation and maintenance of the irrigation works under their jurisdiction.

The 1949 act (Public Law 335, in the 81st Cong.) authorizes the provision of interest-free funds for the rehabilitation and betterment of existing works of Federal Reclamation projects. Such rehabilitation and betterment may be accomplished by any of these means:

1. Under contracts awarded and administered by the Bureau of Reclamation.

2. Under work performance contracts entered into by the water users' organization whereby the organization will be responsible for the work.

3. By force account; i.e., employees of the Bureau of Reclamation. (This method is seldom used except in connection with water users' organizations too small to take on the responsibility of performing the work.)

The second method, whereby the water users' organization accomplishes the work, is the one most often used. For instance, work proposed in fiscal year 1963 on the Gering-Fort Laramie Irrigation District is to be accomplished by the district.

Whether the work is accomplished by the Bureau of Reclamation or by the irrigation district, the actual cost of the rehabilitation and betterment work is repaid to the Government by the water users' organization in installments fixed according to the ability of the organization to repay.

Stilling pool at beginning of pipeline, with weir in foreground, is part of rehabilitation and betterment on North Platte project.

In 1949 officials of the Goshen Irrigation District and the Gering-Fort Laramie Irrigation District negotiated contracts with the Government for certain rehabilitation and betterment work in their respective districts. The amount of work to be done was reduced under amendatory contracts in 1952. The work was completed in June 1958.

Since then, the Goshen Irrigation District has negotiated an additional contract; and when *The Reclamation Era* went to press, an additional contract with the Gering-Fort Laramie Irrigation District had been approved by the Secretary of the Interior.

Gering-Fort Laramie

Under the terms of the Gering-Fort Laramie contract, up to $2 million would be available to the district for improving portions of its distribution system. The District is responsible for the work, which includes:

1. The installation of about 95 miles of buried concrete pipe to replace existing open laterals.

2 The paving of 8 miles of open laterals.

3. Replacement, repair, and betterment of turnouts and other structures in connection with the lateral improvement work.

Some of the district's irrigation works date back to 1915. Most of the 270 miles of open laterals are difficult of access and require excessive costs for operation and maintenance in their present condition and circumstances.

It has been estimated that the proposed improvements will result in annual savings of $17,500 in operation and maintenance costs, and a reduction of water losses by about 10,700 acre-feet annually, an especially important saving in terms of dollars.

Goshen

The Goshen Irrigation District started work on its current rehabilitation and betterment program in October 1961. The work involves the place-

ment of 20 miles of precast irrigation pipelines, diversion boxes, measuring devices, and appurtenant irrigation structures.

The precast concrete irrigation pipe used in this work is manufactured by the Goshen Irrigation District at its own plant in Torrington, Wyo. Expenditures for these and other materials and for labor contribute to the local economy, and in addition, develop benefits from the conservation of water lost from canals and laterals.

Results of R&B Program

A recent survey indicates that the following amounts of rehabilitation and betterment work were done on canals and laterals from inception of the program through fiscal year 1961 in the Fort Laramie Division of the North Platte project:

	Miles
Asphaltic membrane lining:	
Canals:	
Wyoming	9.20
Nebraska	11.50
Laterals:	
Wyoming	23.03
Nebraska	2.57
Concrete lining:	
Laterals:	
Wyoming	3.07
Nebraska	2.68
Concrete pipelines:	
Laterals:	
Wyoming	54.99
Nebraska	14.14
Steel pipelines: Laterals: Nebraska	1.27

Work performed under the rehabilitation and betterment program has resulted in a substantial increase in the efficiency of delivering water to farmlands, and has materially reduced operation and maintenance costs for those canals and laterals where the work has been completed.

The elimination of open laterals by replacing them with buried irrigation pipe is an important factor in reducing maintenance costs. This practice permits the farmer to carry on his farming operations without the inconvenience of open ditches.

Noxious weed control is more easily accomplished at less cost to the district and the farmer. And productive land formerly occupied by open irrigation ditches can be farmed to the maximum extent, thus increasing farm revenue to the landowner. # # #

New Dams Started

Groundbreaking ceremonies were held for Sanford Dam in Texas on June 30. Located north of Amarillo, the dam is the key feature of the multipurpose Canadian River Project which will store water for municipal and industrial use.

Groundbreaking for Blue Mesa Dam, near Gunnison, Colorado, was held July 7. Blue Mesa is a feature of the Curecanti Unit of the Colorado River Storage Project. # # #

With the Water Users

SECRETARY UDALL, MR. BRYANT

Each year the Department of the Interior selects for special recognition individuals or groups from outside the Department whose efforts have significantly assisted in achieving conservation of natural resources.

This year among the seven recipients of the Interior Conservation Service Award was M. D. Bryant, civic leader of San Angelo, Tex., for his outstanding leadership in the field of water conservation and development.

Mr. Bryant was cited for his efforts in behalf of the San Angelo project, now under construction by the Bureau of Reclamation. The citation to him stated: "Not only did you give freely of your time and talents in getting the project started, but you initiated and saw to completion a number of key actions, including organization of the San Angelo Water Supply Corporation and negotiation of the repayment contracts."

The multiple-purpose San Angelo project will store water for municipal and industrial and irrigation use and for flood control, with added benefits of recreation and fish and wildlife conservation.

Other individuals receiving a Conservation Service Award were former Wyoming Senator Joseph C. O'Mahoney; Percival P. Baxter of Portland, Maine; Don G. Fredericksen of Gooding, Idaho; and Joseph W. Penfold of St. John, Virgin Islands. Organizations receiving the award were Phillips Petroleum Co., Bartlesville, Okla., and Smith Research & Development Corp., Lewes, Del.

David A. Scott, who for half a century has had more than a passing interest in development of Utah's Ogden River, recently retired after 25 years as superintendent of the Ogden River Water Users Association.

In 1937, the Bureau of Reclamation completed Pineview Dam on the Ogden River Reclamation project; and, to market the water, the local people formed the Ogden River Water Users Association. Mr. Scott was hired as superintendent and guided the organization from its infancy until his retirement this year.

Friends claim he knows practically every rock in Pineview Dam, and it is certain he is well acquainted with the water resources thereabout. As early as 1911, he helped make a survey of the possibilities of a dam on one of the tributary streams in the area. Later he was in charge of drilling the first artesian well in Ogden Valley, the first of 44 which are now capped off and submerged beneath Pineview Reservior.

New Division Chief

J. CARL PHILLIPS

J. Carl Phillips has been promoted to Chief, Division of Procurement and Property (formerly known as the Division of Property Management) in the Washington Office, after serving as Chief of the Procurement Branch of that Division since January1960.

Mr. Phillips is a career Federal employee with 22 years' service, and has been with the Bureau of Reclamation since 1946.

A native of Spring City, Tenn., he received his B.S. degree in architectural engineering from the University of Detroit in 1931. He is a registered professional engineer in Pennsylvania.

Under recent functional adjustments in the Office of the Commissioner, the Chief of Procurement and Property assumes primary responsibility for regulatory phases of procurement, in addition to responsibilities heretofore concerned with property management. # # #

MAJOR RECENT CONTRACT AWARDS

Spec. No.	Project	Award Date	Description of work or material	Contractor's name and address	Contract amount
DS-5729	Colorado River Storage, Ariz.	Apr. 17	Seven 230-kv power circuit breakers for Pinnacle Peak substation.	General Electric Co., Denver, Colo.	$547,367
DC-5735	Colorado River Storage, Colo.	Apr. 4	Construction of Blue Mesa dam and powerplant	Tecon Corp., Dallas, Tex	13,706,230
DC-5736	Missouri River Basin, Mont.	Apr. 20	Constructing foundations and furnishing and erecting steel towers for 160 miles of Dawson County-Custer section of Yellowtail-Dawson County 230-kv transmission line.	Electric Properties Co., Lincoln, Nebr.	3,141,958
DS-5739	Colorado River Storage, Utah.	Apr. 6	Five 138-kv power circuit breakers for Vernal substation	Federal Pacific Electric Co., Santa Clara, Calif.	132,753
DC-5740	Missouri River Basin, S. Dak.	Apr. 12	Construction of 65 miles of Eagle Butte-Maurine 115-kv transmission line.	Crawford Electric Co., North Platte, Nebr.	614,956
DC-5741	Colorado River Storage, Utah.	Apr. 12	Construction of Vernal substation, stage 01	Donovan Construction Co., St. Paul, Minn.	213,465
DC-5743	Lower Rio Grande Rehabilitation, Tex.	Apr. 16	Clearing and construction of earthwork, concrete lining, and structures for rehabilitation of La Feria Main canal and 17.0 lateral system.	K.F. Hunt Contractor, Inc., and H. and H. Concrete Construction Co., Corpus Christi, Tex.	257,755
DC-5744	Wichita, Kans.	Apr. 12	Construction of Cheney dam, utilizing soil cement on upstream slope, Parts A and C.	Cimarron Construction Co., and Williams Brothers Co., Tulsa, Okla.	6,661,961
DC-5745	Vale, Oreg	Apr. 18	Construction of Bully Creek dam and feeder canal	H. O. Montag and W. H. Gregory, Portland, Oreg.	1,689,901
DC-5747	Missouri River Basin, Mont.	Apr. 19	Construction of earthwork and structures for East Bench canal, Sta. 1302+00 to 2035+00; East Bench laterals 21.3 to 34.4, inclusive; and wasteways and drains.	CLZ Canal Contractors, Dillon, Mont.	1,644,854
DC-5748	Chief Joseph Dam, Wash.	May 4	Construction of earthwork, 7 miles of pipelines, concrete-lined storage reservoir, Relift pumping plant, North and South Booster pumping plants, and main discharge line for lateral No. 1 and sublaterals, Howard Flat unit lateral system.	B & B Plumbing & Heating, Inc., Anacortes, Wash.	533,050
DC-5749	Central Valley, Calif	Apr. 30	Construction of earthwork, pipelines, and structures for El Dorado main and laterals; and laterals for Diamond Springs main, El Dorado distribution system, Schedule 1.	Beasley Engineering Co., Emeryville, Calif.	489,817
DS-5751	Colorado River Storage, Ariz.-Utah.	May 16	Two main control and graphic boards, three relay boards, two distribution boards, and one sequence operation recorder, board, and equipment for Glen Canyon powerplant.	Westinghouse Electric Corp., Denver, Colo.	218,727
DC-5753	Colorado River Storage, N. Mex.-Colo.	Apr. 23	Construction of 101 miles of Cortez-Curecanti 230-kv transmission line, Schedule 1.	Electrical Constructors, Columbus, Ohio.	4,224,514
DC-5753	do	do	Stringing conductors and overhead ground wires for 42 miles of Shiprock-Cortez 230-kv transmission line, Schedule 2.	Malcolm W. Larson Contracting Co., Denver, Colo.	522,152
DS-5754	Central Valley, Calif	May 23	Designing and constructing additions to Elverta substation, Folsom powerplant, Sacramento power control office, and Tracy switchyard.	Wismer and Becker Contracting Engineers, Sacramento, Calif.	815,000
DS-5755	Colorado River Storage, Ariz.	May 16	One 450,000-kva autotransformer for Pinnacle Peak substation	Westinghouse Electric Corp., Denver, Colo.	431,005
DC-5760	Colorado River Storage, Colo.	May 11	Construction of 180 miles of Curecanti-Craig 230-kv transmission line.	Morrison-Knudsen Co., Inc., Boise, Idaho.	6,923,100
DC-5764	Missouri River Basin, S. Dak.	May 11	Construction of 95 miles of Winner-Mission-Martin 115-kv transmission line.	O.K. Electric Co., Inc., Omaha, Nebr.	893,786
DC-5766	Colorado River Storage, Ariz.	June 22	Construction of 240 miles of Glen Canyon-Flagstaff-Pinnacle Peak 345-kv transmission line.	Ets-Hokin and Galvan, Inc., San Francisco, Calif.	12,847,830
DC-5767	Central Valley, Calif	May 18	Construction of earthwork, structures, and concrete pipelines for Madera distribution system, Part 3 extension.	McGuire and Hester, Oakland, Calif.	751,234
DS-5768	Missouri River Basin, N. Dak.-S. Dak.	June 5	Two 10,000-kva trailer-mounted mobile autotransformers for Region 6, Schedule 2.	General Electric Co., Denver, Colo.	144,340
DS-5769	Parker-Davis, Ariz	May 18	Eleven 14.4-kv replacement power circuit breakers for Phoenix substation.	I-T-E Circuit Breaker Co., Power Circuit Breaker Division, Los Angeles, Calif.	158,490
DC-5770	Missouri River Basin, Nebr.	May 29	Construction of earthwork and structures for 14.1 miles of concrete-lined Ainsworth canal, Section 2.	Bushman Construction Co., St. Joseph, Mo.	2,384,998
DC-5772	Columbia Basin, Wash.	June 13	Construction of Moses Lake control structure	Cherf and Associates, Inc., Ephrata, Wash.	148,944
DC-5773	Weber Basin, Utah	June 15	Construction of Causey Dam	R. A. Heintz Construction Co., Portland, Oreg.	3,836,419
300C-159	Colorado River Front Work and Levee System, Ariz.-Calif.	Apr. 18	Construction of 10.5 miles of haul roads and bank protection structures; and developing quarry sites, Palo Verde Valley.	Wes. J. Foster, Inc., Fullerton, Calif.	411,711
400C-202	Provo River, Utah	June 18	Construction of earthwork and structures for Provo River channel revision, Mile 32.1 to 38.4 below Duchesne tunnel.	Evan W. Ashby, Salt Lake City, Utah.	236,521
500S-120	Lower Rio Grande Rehabilitation, Tex.	Apr. 12	Approximately 116,100 linear feet of unreinforced and reinforced concrete pressure pipe and 1,580 feet of concrete culvert pipe for Mercedes division.	W. T. Liston Co., Harlingen, Tex.	398,744
DC-5750	Colorado River Storage, Ariz.-Utah.	June 25	Completion of Glen Canyon powerplant, switchyard, dam, and appurtenant works.	Ets-Hokin & Galvan, Inc., San Francisco, Calif.	7,891,272
DC-5776	Fort Peck, Mont	June 29	Construction of Richland substation, Stage 01	Electrical Builders, Inc., Valley City, N. Dak.	155,819
DS-5784	Colorado River Storage, Ariz.-Utah.	June 27	Three 100,000-kva autotransformers for Glen Canyon switchyard.	Westinghouse Electric Corp., Denver, Colo.	351,010
DC-5786	Weber Basin, Utah	June 26	Construction of the third stage of Willard Dam	W. W. Clyde and Co., Springville, Utah.	4,712,470
DC-5793	Norman, Okla	June 28	Construction of Norman Dam and relocation of State Highway No. 9.	Cosmo Construction Co., Oklahoma City, Okla.	3,692,177
DS-5794	Colorado River Storage, Utah-Wyo.	June 29	Three 20,000/26,667/33,333-kva autotransformers for Flaming Gorge switchyard, Stage 01.	Pennsylvania Transformer Division, McGraw-Edison Co., Canonsburg, Pa.	184,283

U.S. GOVERNMENT PRINTING OFFICE. 1962 O—643642

Major Construction and Materials for Which Bids Will Be Requested Through August 1962*

Project	Description of work or material
Central Valley, Calif.	Constructing the pump discharge line and main aqueduct for the Cow Creek Distribution System consisting of about 8 miles of 36- to 54-inch-diameter precast concrete pressure pipe, pretensioned concrete cylinder pipe, noncylinder prestressed concrete pipe, or mortar-lined and mortar-coated steel pipe, a 115- by 115-foot concrete-lined reservoir, a steel storage tank 80 feet in diameter and 115 feet high and a steel surge tank 20 feet in diameter and 110 feet high. Near Redding.
Do	Constructing about 23 miles of pipe laterals varying in diameter from 12 to 33 inches. Pipelines to be constructed of noncylinder prestressed concrete pipe, pretensioned cylinder-type concrete pipe, or mortar-lined and mortar-coated steel pipe. Cow Creek Unit Pipelines, near Redding.
Do	Constructing about 4 miles of canals with bottom widths varying from 8 to 3 feet, about 14 miles of earth dikes with top width of 12 feet and heights varying from 10 to 3 feet, drilling or jetting about 85,000 linear feet of infiltration holes and installing 4-inch-diameter perforated pipe surrounded by gravelly materials. Holes will average about 75 feet deep. San Luis Canal, near Los Banos.
Do	Eight Francis-type, vertical-shaft pump turbines each with a pumping capacity of 1,375 cfs at a total head of 290 feet for San Luis Pumping-Generating Plant.
Do	Eleven 60- by 18-feet fixed-wheel gates for the overflow weir and sluiceway at Red Bluff Diversion Dam. Estimated weight: 1,000,000 pounds.
Colo. Rvr. Storage, Colo.	Clearing about 480 acres of trees and shrubs and removing one steel truss railroad bridge from Morrow Point reservoir site, about 25 miles east of Montrose.
Do	Constructing about 17 miles of gravel-surfaced road in the Blue Mesa Reservoir area, about 24 miles west of Gunnison.
Colo. Rvr. Storage, Ariz.-New Mex.	Eight 230-kv, single-circuit towers permitting aluminum or steel tubular shapes or prestressed concrete structures for the Glen Canyon-Shiprock Transmission Line.
MRBP, Kans	Constructing Norton Dam, a 3,700,000-cubic-yard earthfill structure, 100 feet high and 6,450 feet long, and appurtenant works, including a gated-chute-type spillway and concrete conduit outlet works. Work will also include constructing about 2 miles of county road relocation. On Prairie Dog Creek, about 2.5 miles southwest of Norton.
MRBP, So. Dak	Furnishing and installing fence gates, clearing right-of-way, constructing concrete footings, and designing, testing, furnishing, and erecting steel towers for about 147 miles of 230-kv, double-circuit Fort Thompson-Sioux Falls Transmission Line.
Do	Constructing foundations and furnishing and erecting towers and 12- by 12-foot building for VHF radio repeater sites at Martin, Dupree, Okreek, and Fairpoint. Work will also include installing Government-furnished radio equipment at the four sites and additional buried cable installations at Martin site.
The Dalles, Oreg	Constructing the Mill Creek Pumping Plant in the face of a basalt cliff bank of the Columbia River. The structure is to be a reinforced-concrete, outdoor-type plant with about a 30- by 69-foot operating deck at approximate elevation 105.5, with the base slab at approximate elevation 63.25. Work will also include installing five vertical-shaft pumps with a total capacity of 54.2 cfs at a total head of 228 feet. At The Dalles.
Weber Basin, Utah.	Earthwork and structures for about 9.1 miles of 10-foot bottom width earth-lined Layton Canal, and about 10 miles of open ditch drains and relocated ditches. Near Ogden.

***Subject to change**

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What's Coming:

Lake Powell Survey

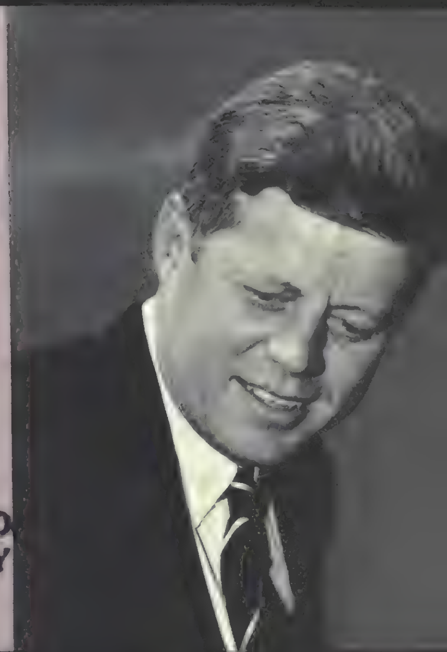
Land Subsidence in the Valley

Official Publication of the Bureau of Reclamation

Reclamation ERA

RECLAMATION MILESTONES —

President Kennedy flies to South Dakota, Colorado and California on a Reclamation trip *(on pages 98-99). . . .*



NOVEMBER 1962

The Reclamation Era

NOVEMBER 1962 VOLUME 48, NO. 4

In this issue . . .

OTTIS PETERSON, Assistant to the Commissioner—Information
GORDON J. FORSYTH, Editor
KATHRYNE DIMMITT, Art Editor

Cover photo by—
Stanley J. Rasmussen

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American Indians...

HELPING TO BUILD THE NATION

Native Americans, whose forefathers were brave and determined Indians fighting in a vital cause, are today capable United States citizens working in essential industries and helping to build the Nation.

Indian war drums of yesteryear are silenced, except perhaps for a ghostly echo that today stirs visions of the heroic past in the minds of all American races. The awesome sounds that led to battle less than a century ago are replaced by the sounds of a Nation still being built by the descendents of earlier Americans—Indians and white men—who work competently side by side.

Background sounds of today include the din and roar of construction in steep-walled canyons where men, frail in comparison to their gigantic surroundings, are building Bureau of Reclamation dams to control unruly rivers for useful purposes.

Today's situation for the Indian is being attacked primarily on economic and sociological fronts and is often an individual matter. But in his modern problem, he finds he has strong allies who will familiarize him with the path to an industrial job—requirements for union membership, payment of dues, hiring through union halls, specialized skills, and other problems encountered for the first time by the Indian away from his reservation.

Units of two of the Bureau of Reclamation's biggest water development projects are in Indian territory where contractors are attempting to furnish equal employment opportunities to Indians on these units. One such unit is Glen Canyon Dam, Ariz., on the 5-State Colorado River Storage project, and another is Yellowtail Dam, Mont., on the 10-State Missouri River Basin project.

Yellowtail Dam, a 1,750,000-cubic-yard concrete giant, being constructed in the heart of the Crow Indian Reservation on the Bighorn River in southeastern Montana, just 43 air miles southeast of Billings, Mont., must have a universal air as far as the American Indian is concerned.

Yellowtail Constructors are the prime contractor building the dam and powerplant, features of the Yellowtail unit, MRBP, and while they do not maintain records on individual employees indicating their race, creed, color or religion, a quick leg survey of the job and a few questions will produce representatives from at least eight Indian tribes. These range from the highly populated

The nimble highscaler on this canyon wall is a 31-year-old Navajo.

Blackfeet Nation in northern Montana to the now nearly depleted Kaw tribe from southern Kansas.

Along these high great plains, where, once, more than 30 Indian tribes worked, played and lived, a tremendous program of natural resource development is under way. The Great Plains Indian of today has an awareness of that program and is likely to use his talents in various ways in developing the area's resources.

Although, if he chooses, the modern plains Indian can live on the reservation, and if he so desires, find, through the custom of community-sharing, shelter and food. He also realizes he has certain rights associated with his dignity as a man—compelling factors in his desire to better serve personal and family needs beyond those of mere existence.

Indians, like other minority groups, often encounter racial prejudices and find that progress on the economic ladder is not easy. Jobs are hard to find in an area of small communities and limited industry.

Remedy for Job Problems

The development of the natural resources in the Missouri River Basin is providing an opportunity for many a Great Plains Indian seeking a decent living and reasonable comforts for himself and family. The Indian, however, is somewhat handicapped in seeking and holding employment.

Although the same regulations and requirements for jobs are applicable to all, the Indian, lacking the experience in these matters, is generally less able to cope with the situation. Education in job seeking, procedure and training in specialized fields is required.

Alan Leisk, 33-year-old labor coordinator for the Yellowtail Constructors, is a graduate of Stanford University, majoring in psychology. Although a young man, he is a 6-year veteran of labor relations experience with a huge internationally known construction firm, Morrison-Knudsen Co., Inc., one of five firms engaged in a joint venture constructing Yellowtail Dam and powerplant.

Mr. Leisk believes that the numerous problems in the area can be alleviated by improved coordination between the Indians and the labor unions. Remedies he has suggested include an educational program among the Indians both in job-seeking technique and impressing upon the Indian the rewards to be derived from responsibility and dependability.

Yellowtail Constructors officials believe a program definitely devising methods to create interest and guide young, capable Indians into seeking apprenticeship opportunity in the skilled labor fields should be vigorously pursued.

Indian Counseling

According to Clyde P. Larsen of the Bureau of Indian Affairs, whose regional office is located in Billings, Mont., that agency has established a liaison representative at Yellowtail Dam to keep the Indians informed of local job opportunities. Through this method of counseling, it is planned to advise Indians seeking employment of proper procedures, to counsel them on the adaptation of their particular skills to the demands of the job opening, and to advise them as to the necessity for meeting the requirements of organized labor.

A spirit of full cooperation exists between the Bureau of Indian Affairs, Bureau of Reclamation, and the Yellowtail Constructors, and officials of both Government agencies and Yellowtail Constructors are in absolute agreement that the phrase

"No discrimination regardless of race, religion, color or creed" applies to all men.

The labor trades and councils are cooperating in finding employment for the Indians by stationing a representative at the Crow Indian Reservation 2 days a week. By interviewing applicants and analyzing their qualifications, union representatives can tell best where the available Indian manpower can fit into the requirements of Yellowtail Constructors.

Varying Skills

The Indian himself, like members of other races, is possessed with different and varying degrees of skill. On the job for the Yellowtail Constructors are hard-rock miners, drill helpers, Euclid operators, pipefitters, carpenters, and many others.

Some of these, for instance, are Leo E. Cooper (shown in picture on p. 85), a Euclid operator who has worked on various construction jobs in the West; Robert Kust, from the Sioux tribe, who is a pipefitter, having completed a 5-year apprenticeship program in 2½ years; Al Cliff, an Assiniboin Indian, and former steel mill worker in the midwest; Arlen Whiteman, a Crow Indian, who is a relatively new employee in the construction business but plans to remain on that activity; and Willis Medicine Horse, Jr., who, like Mr. Whiteman, is a chucktender, a helper on drilling crews that drill deep into the mountainside for the placement of explosives.

There are Indians from many areas employed at Yellowtail. For instance, from the plains of Oklahoma via the Minnesota lake country comes Al St. Germaine, a Chippewa, a carpenter and a real construction veteran.

It is anticipated that the combined payroll of both Government and private industry will peak at about 1,200 people before the first storage of water and generation of hydroelectric power takes place at Yellowtail Dam in 1966. Construction of this multiple-purpose unit of the Missouri River Basin project provides a lift to the economy of the area.

As the construction figure rises, the number of Indians participating in the construction will undoubtedly also increase. Roscoe Granger, project construction engineer for the Bureau of Reclamation, is "well pleased" with the Indians working under his supervision. Excepting those career personnel with highly skilled qualifications who have been transferred into the Yellowtail area, a considerable number of persons hired to perform the technical and field duties of the Bureau unit offices are Crow Indians.

"Well pleased," Mr. Granger emphasized again and praised highly such men as Lorenzo Mountain Sheep, instrumentman; Owen Smell, rodman; and Leo Plainfeather; and for a rugged, aggressive construction engineer, his eyes really beam when he refers to Mort Dreamer, a technician in the concrete lab, working in close harmony with Doug Wood, veteran concrete specialist for the Bureau.

Indians and Glen Canyon Dam

Glen Canyon Dam too is in Indian country. The high mesas, valley floors and deep side canyons that range near Glen Canyon have been the traditional homes of nomadic tribes for many centuries. Today, to the northwest in Utah, are the Paiutes; to the northeast, in Colorado, are the Utes; and to the south are the Hopis.

Dominating the area, however, is the great reservation of the Navajos, which covers 16 million acres stretching from Grand Canyon National Park in the west to Farmington, N. Mex., in the east. The reservation is bordered in the north and west by the Colorado and San Juan Rivers.

When the Bureau of Reclamation came in 1956 to build Glen Canyon Dam, the key unit in the Colorado River Storage project, the entire south rim of the canyon was part of the Navajo Reservation. Negotiations were started with the Navajo Tribal Council, and in 1958 about 53,000 acres, enough for the dam, the site of Page, Ariz., and

Indian artist for the Bureau, a widely acclaimed painter.

the reservoir were turned over to the Government in return for a similar-sized section of grazing land in southeastern Utah.

Providing Opportunity

The Department of the Interior has always been charged with a responsibility for Indians. Today, the emphasis is on teaching Indians new skills and on obtaining suitable jobs for those qualified. At Glen Canyon Dam, the Bureau of Reclamation asks all contractors to give equal employment opportunities to all Indians commensurate with their qualifications. The ensuing cooperation has been excellent.

The prime contractor for Glen Canyon Dam, Merritt-Chapman & Scott Corp., provided employment for many Navajos during the excavation period from 1956 to 1960. At one time over 100 of them were on the payroll out of a total work force of some 1200 men. Some have served as equipment operators and carpenters.

With the placing of concrete, which began in 1960, the need for laborers declined as the need for skilled crafts rose. In consequence there are now only 47 Navajos working for the prime contractor out of a total of about 1,700. Officials of MCS state that they have been highly pleased with these Indians.

In addition to those Navajos working for the contractor, there are about 5 to 20 Navajos working for the Bureau of Reclamation, most of them on survey and maintenance crews. The number varies according to the work at hand. Two of these men, Abe Begay, a blueprint machine operator, and Louis Dodson, a surveying aide, have recently received superior accomplishment awards for their work during the past year.

Pete Yazzi, 27-year-old Navajo vibrator operator settling concrete.

One of the most highly skilled Navajos at Page is Hoke Denetsosie (shown in picture on page 87), who serves as an illustrator for the Bureau of Reclamation. He is one of the most accomplished painters in the Navajo tribe and many of his paintings are hanging in museums throughout the Southwest. His work for the Bureau includes preparing artist's conceptions and making up exhibits.

Glen Canyon Dam is scheduled to be topped out in the spring of 1964 and the first power will go on the line that same year. To carry the power to load centers, the Bureau is now constructing a long backbone transmission line east to New Mexico and then into northern Colorado.

Another line, 240 miles in length, is being built from Glen Canyon Dam to a point near Phoenix, Ariz. Therefore, many miles of these lines will cross the Navajo Reservation and will afford more Navajos opportunities for employment.

The 182-mile stretch of the transmission line from Glen Canyon Dam to Shiprock, N. Mex., is also under construction. John Freeman, field superintendent for Electrical Constructors of Columbus, Ohio, states, "We now have a force of about 55 men of which 30 are Navajo Indians, many of whom are skilled and semiskilled. This is our company's first experience with Navajos, but we have been pleased with their work."

Among Indians working on various phases of construction of the dam and transmission lines are Pete Yazzi (shown in picture on this page), a Navajo laborer who was promoted to vibrator operator and later began a carpenter apprenticeship; George Charlie (shown in picture on page 86), is a Navajo highscaler, a job that takes iron nerve; Carl Henry, a Paiute, is a heavy-equipment operator; Harry Betes, a Navajo is also a heavy-equipment operator; and Harvey Nelson, another Navajo, is employed as a truck driver.

These Indians and others like them working on Bureau of Reclamation projects, are finding opportunities for themselves in the modern world of machines. At the same time, they are also providing material assistance to the further development of the West, which will bring additional benefits to them and their fellow citizens. # # #

The Lake Powell Survey Story

by CLYDE D. GESSEL, Chief, Special Studies Branch, Division of River Control, Bureau of Reclamation, Salt Lake City, Utah.

Filling of Lake Powell behind massive Glen Canyon Dam will make many changes along 180 miles of the Colorado River and 71 miles of the San Juan River, and a watchful eye will be kept on the geologic changes.

When Lake Powell stores its 28 million acre-feet of water and settles its supply of silt, both weighing 38 billion tons, geologic shifts and depressions may occur. With that much weight added to even the mighty Colorado's red sandstone channel, there is likely to be some depression in the surrounding earth's crust.

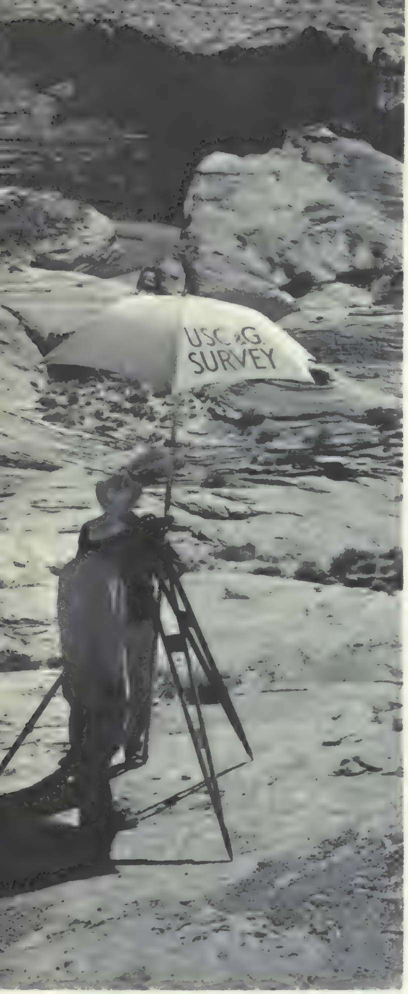
Bureau of Reclamation engineers compensate for this eventual movement of the crust, and they have designed a network of precise geodetic level lines to cross the canyon at Glen Canyon Bridge and to traverse the main portions of the Lake Powell Basin. The Bureau then made a contract with the Coast and Geodetic Survey, Department of Commerce, to work in the spring and summer of this year and perform the precise leveling, installing a system of permanent bench marks according to the design.

Powell, the name given to the proposed lake, comes from the famous Major John Wesley Powell. He surveyed and scientifically explored the Colorado River in 1869 and 1871.

Major Powell and his party are credited with conquering the river by boat. Starting in Wyoming, he made the expedition and took pictures along the way. A rare picture of Major Powell and his second survey team standing ready at Green River Station in Wyoming, was borrowed from the National Archives for use in *The Reclamation Era.*

The river had been named "Firebrand" probably because of the resemblance of its deep-cut sandstone banks to a wavy band of fire.

For picture above—Anchoring equipment with weights and guy wires the crew "dug in" for 2.3-mile reading across from Hole-in-the-Rock.



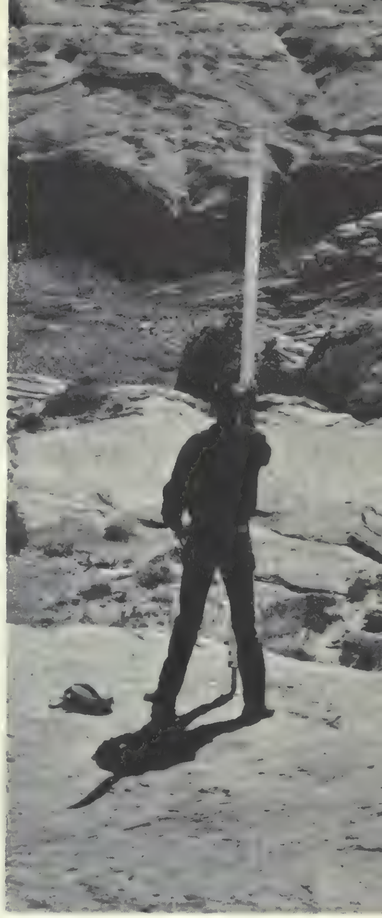
(1871 photo) Major Powell standing on boat at right; at left is hooded camera or survey instrument.

(*"The Lake Powell Story" begins on the preceding page.*)

Other adventurous people have tackled the deceptive waters of "Firebrand," and some have braved the desolate country around it. But today's survey team, using modern means of transportation and communication, stoutly avow that this canyon land and its desert plateaus still impose tremendous difficulties on the movements of leveling crews.

In making their survey, the C. & G.S. traversed the canyon and other rugged country in the task of recording 200 perfect readings. They installed the marks many miles apart on both sides of the river at points above the expected waterline of the lake.

In a few years, or at any desired time, when the area is checked again, the leveling instrument can be plumbed directly over the marker installed by C. & G.S. during this year's early preparations.



Level lines recorded and filed this year by the crew will provide data to measure the movements of the earth's crust due to the weight of the water, sediment, and the dam. Also, they will provide for measuring the depth of sediment in the reservoir, and for locating lakeside improvements at a later time. # # #

Captions: On the opposite page, Major Powell is shown with his group ready to start their 1871 journey/ Two men of the C&GS crew take a 1962 level line reading across the canyon/ The helicopter which carried the crews from one point to another is shown hovering over the rocky path of Hole-in-the-Rock/ Coming from Page, Arizona in an air plane gave the crew a bird's eye view of the lake-to-be/ In a quiet desert setting, the crew set up a 60-day camp with Navajo Mountain, the area's tallest, looming up behind the rocks. A desert road in front of the tents runs over sand, rocks and high sandstone mounds.

On this page, the helicopter sets down on a ledge overlooking the Colorado River/ A surveyor holds the rod for a teammate across the canyon/ A photographic expedition made up of a university group rode in jeeps to Hole-in-the-Rock to take pictures/ While running level lines across Billy Flat, one surveyor wears a white sack over his head because he was bothered by biting gnats.

(1953 photo) Jeep travel over land was

LAND SUBSIDENCE IN
when water makes

by NIKOLA P. PROKOPOVICH and ROBERT J. FARINA, Engineering Geologists—Geology Branch, Division of Project Development, Sacramento, Calif.

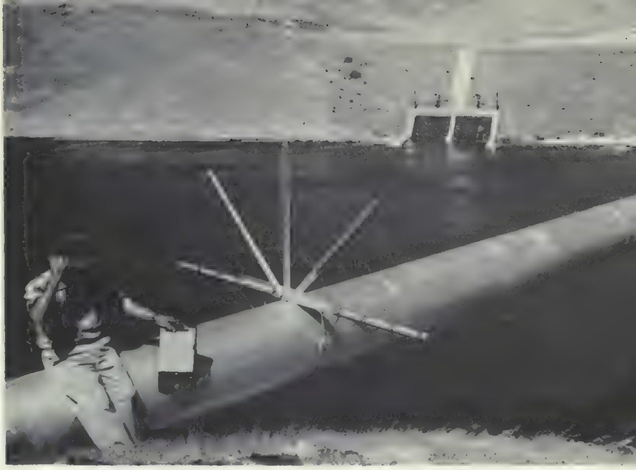
A unique geologic phenomenon in California is getting some close attention from the Bureau of Reclamation because of its bearing on features of the giant San Luis unit which is now under construction. The unit will be an important addition to the Bureau's Central Valley project as well as a link in the State of California's water plan.

A major part of the unit is the San Luis Canal which will extend about 103 miles along the western margin of the San Joaquin Valley, between the San Luis Reservoir and Kettleman City. And that's where the geologic problem—land subsidence—comes in.

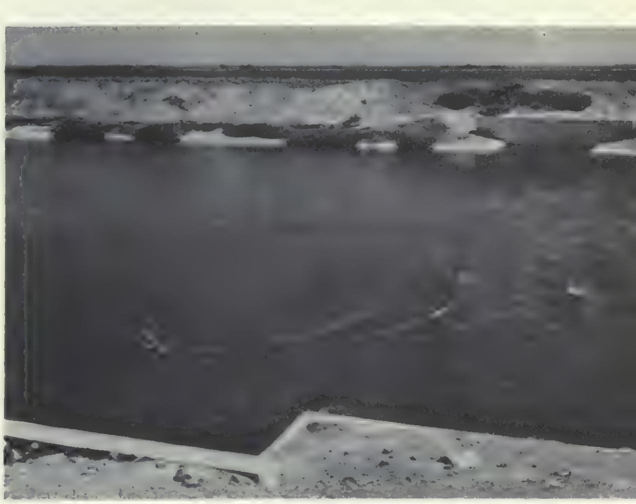
Land subsidence troubles become evident in water developments if certain irregularities occur. It could be subsidence when a small patch of land settles or caves in near or in a canal, land could slump in a particular area causing water to pool or overflow, or subsidence might change vast acres to a lower elevation or slope them a different way.

Subsidence is found in the general area that is shaded. Withdrawal of ground water causes subsidence in most of the area. Other causes are applying surface water, compaction of peat deposits, and withdrawal of crude oil.

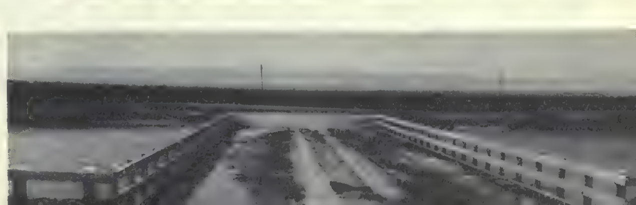
THE VALLEY soil slump



Above: Pipe clearing water normally. Below: Deep subsidence lowers pipe is submerged in water. Delta-Mendota Canal in Californi



Above: Normal clearance of farm bridge. Below: Water pools and r over as the bridge lowers with deep subsidence. Delta-Mendota Can



Subsidence is frequently related to such works of man as withdrawal of ground water or crude oil, irrigation, and mining. In many cases it has caused serious and costly damage to irrigation canals, wells, pipelines, buildings and other such structures. In one form or another, it also is known in foreign lands and in other parts of the United States.

Within the State of California, subsidence, due to compaction of peat deposits, drilling wells for ground water or crude oil and surface water application, are known in several areas as shown on the map. A complicating factor of the subsidence along the San Luis Canal alinement is the presence of two entirely different types of subsidence: "deep" subsidence, caused by withdrawal of ground water, and "shallow" subsidence, caused by irrigation.

About 80 miles of the San Luis Canal alinement are in areas affected by deep subsidence which proceeds rather slowly over a widespread area. Some 1,100 square miles are affected by such subsidence in the vicinity of the canal line—Los Banos-Kettleman City area—similar subsidence also occurs in the Tulare-Wasco and Arvin-Maricopa areas.

Total area affected by well-defined deep subsidence within the San Joaquin Valley is at least 2,000 square miles, with traces noted over a much larger area. The cause of deep subsidence in the San Joaquin Valley is withdrawal of confined ground water which results in compaction of sands, silts and clays.

A definite relationship exists, therefore, between the lowering of the ground-water levels and deep subsidence. Ground-water level in the San Luis area has been lowered as much as 400 feet between 1904 and 1960 and has caused subsidence ranging from a trace to over 25 feet. In the Tulare-Wasco area, importation of surface irrigation water from

the Bureau's Friant-Kern Canal caused up to a 100-foot rise of the ground-water level between 1951–57 and subsidence virtually ceased. Therefore, deep subsidence in the San Luis area is expected to decrease greatly when ground-water levels are stabilized, probably a few more years after the start of canal water deliveries.

San Luis Canal will not be the first Bureau structure to be located in a "deep" subsidence area. Two major canals, the Delta-Mendota and the Friant-Kern, also on the Central Valley project, are located in the areas affected by such subsidence. In 1951, when the Delta-Mendota Canal was completed, the phenomena of subsidence was not clearly established in this area. Detrimental engineering effects are now particularly obvious.

In some reaches of the canal, bridges, pipe crossings and other structures normally supended over the water surface are more or less submerged. Concrete lining is frequently topped, and the change in slope has slowed the flow so that the canal capacity is reduced.

The Friant-Kern Canal was completed in 1951, partly in a known subsiding area. In this case the detrimental effects of subsidence were greatly neutralized by engineering design. Similar and even more advanced design features will be used for the San Luis Canal to compensate for deep subsidence.

The second and entirely different type of subsidence in the San Luis area is so-called shallow or near-surface subsidence. It is superimposed over deep subsidence and is clearly caused by irrigation and other types of surface water application. This subsidence is a form of compaction of some dry, "fluffy" sediments. Along the San Luis Canal alinement shallow subsidence is essentially limited to two areas and will affect about 20 miles of the alinement.

Shallow subsidence causes soil cracking, differential settling and slumpage. In general it is more rapid and destructive than deep subsidence and causes heavy damage to irrigation systems, roads, buildings, powerlines and pipelines. Spectacular effects occurred at some experimental test plots in unirrigated areas where the ground has dropped 10 feet or more in a series of steps.

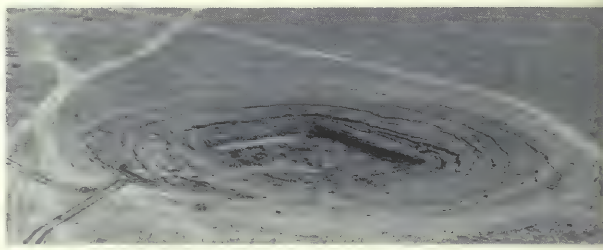
Information concerning the nature, extent and rates of subsidence is necessary to design an economical structure that will perform efficiently over the life of the project. Careful studies of subsidence in the San Joaquin Valley have been conducted by various organizations and, in 1954, an Interagency Committee on Land Subsidence in the San Joaquin Valley was established.

A particularly comprehensive geologic study of shallow subsidence is now being made by the Bureau in the vicinity of the San Luis Canal alinement. This study includes drilling of numerous test holes, special types of soil sampling, laboratory study of the samples, detailed topographic surveys, a ground-water measurement program, and operation of subsidence test plots. These plots are experimental ponds about 125 feet square.

The study will delineate areas susceptible to shallow subsidence and will provide data required to design the most efficient preconstruction treatment.

The most practicable plan of preconstruction treatment is to flood the canal alinement and produce the major amount of shallow subsidence before the canal is excavated. This flooding will preconsolidate soils along the alinement and minimize subsidence after construction of the canal.

# # #



Above: Test plot of land in aerial photo shows shallow subsidence lowering of 12 feet. Below: Shallow subsidence causes large crack.

installing PLASTIC LINING in McCaskey Lateral

by CHARLES N. SMITH, Civil Engineer, Irrigation Operations Branch, Irrigation Division, Amarillo, Tex.

When agricultural land becomes too wet, farmers have difficulty keeping it in production. Some farmers in New Mexico have this problem on land near irrigation canals and laterals and a program is now in progress to fight it with a water sealant of plastic or, more specifically, polyvinylchloride membrane linings.

High ground water on farm land is caused by excessive seepage from nearby waterways, and by poor drainage. Either the drainage or the seepage problem can cut agricultural production seriously, so a vigorous atack on the situation in the vicinity of Tucumcari has been launched by the Arch Hurley Conservancy District Board. They are working for quick results.

Back in March 1961, the district board executed a rehabilitation and beterment contract with the Bureau of Reclamation to finance a 5-year program of drainage and canal lining work. In May, they started investigations on the Bureau-built Tucumcari project.

Investigations determined that McCaskey lateral on the project, had excessive seepage of water into shallow soils underlain by a dense clay barrier which prevented deep percolation. An account was provided of the R. & B. contract method employed to line a 6,500-foot reach of McCaskey, and evaluations were made of its effect and cost.

Funds for the jobs, so work could start early, were advanced from the district until appropriated funds could become available.

Vinyl membrane, $\frac{1}{100}$ of an inch thick, was purchased in sheets approximately 35 feet wide and 500 feet long. The sheets arrived from the manufacturer folded accordianlike, and packaged in reinforced cardboard boxes weighing 1,200 pounds each. Thirty-two thousand, two hundred and eighty-two square yards of vinyl plastic film was purchased at a price of $15,323 for lining the McCaskey and other laterals on the project.

Excavation of the lateral prism was performed by three-fourth cubic yard dragline machines

For picture above: One end of the plastic was taken out of top case on the truck (left) and brought across to other side of the lateral.

Old tires were rolled down the slopes over the plastic so workmen could control the vinyl membrane in winds.

cutting the banks back to 2 to 1 slope. The dragline operator cut the bottom 1 foot below design level attaining an exactness in excavating with a lightweight steel template, which he used as a visual guide.

Surface smoothing was then started by dragging a heavy chain along the lateral prism with vehicles pulling on each side.

The chain dragging effectively broke larger clods of earth and moved remaining clods to the lateral bottom. This was followed by handraking the slopes toward the bottom.

At this point, approximately 10 cubic feet per second of flow was released into the lateral long enough to wet the bottom, to soften the clods, and permit remaining clods to be settled into the saturated-earth bed.

Anchor trenches were excavated along each side of the lateral with motor graders. Ridges of the trenches were hand-raked so toeing in could be done without tearing or cutting the vinyl at points where stress would be expected if it settled or tightened.

Earth was also hand-excavated at concrete structure sites to expose cutoff walls where the vinyl would be cemented to the structure with an asphalt mastic cement.

Placing the vinyl membrane progressed rapidly when preparation of the lateral was complete. Flatbed trucks loaded with the boxes of vinyl were driven on the maintenance roadway to the end of the lateral and a box of plastic on top of the load was opened. Motor graders, and workmen with shovels were brought to the site. One end of the plastic in the open box was pulled out and across, to the other side of the lateral, the pulling being aided by its accordianlike folding in the box. Tearing or puncturing the material on the edges of the box was avoided because the box material was cardboard.

The vinyl was placed by men stationed along each toe-in trench, one or two men in the lateral bottom, and one on the truck assisting with unfolding. With hand shovels, workmen partially backfilled the trenches with dirt to secure the vinyl in place until the motor graders could backfill the

Cleaning out around concrete structures like the farm turnout (left) permitted cementing the lining to structures with asphalt mastic.

trenches. Securing the membrane in moderately windy weather required more precautions. Old automobile tires were rolled down the slopes to keep out the wind until the graders could blade dirt over the slopes.

Almost immediately after placement, more backfill was put over the membrane with the machines.

The end of one sheet of membrane was lapped approximately 3 feet over the end of the adjoining sheet to provide a relief lap every 500 feet, as well as where uplift seepage might be expected in the lateral bed. The relief laps were constructed by hand-excavating a transverse trench along the upstream end of each sheet of plastic, placing approximately 3 feet of plastic into the trench and backfilling over the end of the sheet before overlapping 3 feet of the next sheet of plastic. The overlap was not cemented to permit the escape of seepage water trapped under the lining.

At concrete structures in the lateral, the plastic was cut and cemented to the structures.

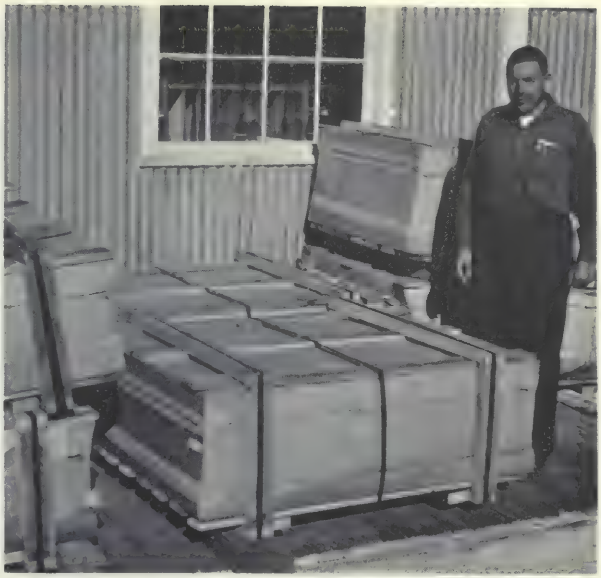
After partially backfilling the lateral slopes, the beaching zone along the upper part of the slopes was backfilled with 12 inches of gravelly material to resist slope erosion.

Due to dry weather, the lateral was placed into service almost immediately following placement of the membrane and prior to completion of backfilling. Irrigation deliveries were made from the lateral with checked velocity so that backfilling could be completed at the same time. This resulted in a satisfactory cover, but probably somewhat increased the cost of backfilling.

Equipment and labor costs for installing the 26,640 square yards of lining in the McCaskey lateral, excluding depreciation of equipment, are as follows:

Item	*Cost per square yard of vinyl membrane*	*Total cost*
Excavation ($0.17 per cu. yd.)	$0. 07	$1, 865
Installing vinyl membrane	. 09	2, 459
Backfilling and gravel protection	. 12	3, 123
Purchase of vinyl material	. 47	12, 654
Total	. 75	20, 101

Early evaluations of the vinyl membrane indicate a very impervious lining. On one farm, approximately 30 to 40 acres of land were previously seeped excessively making it impossible to cultivate or to support crops. This land is now being cultivated and returned to productivity.



Boxes loaded on the dock contain the plastic as it arrived from the manufacturer in reinforced cardboard boxes. Sanford Caudill, Manager of Arch Hurley Conservancy District, stands beside the heavy boxes.

Observation wells paralleling the lateral previously maintained high water levels during irrigation season, with maximum readings at ground level. These same wells, 7 and 8 feet deep, following 4 months' service, were dry during midsummer, indicating practically a cessation of seepage.

Although results have been encouraging and costs reasonable, some factors remain to be evaluated in the use of the buried vinyl membrane linings. A few gopher burrows have been observed in the lateral embankments near the high-water level. Careful removal of the cover materials indicates that gophers are not discouraged by the vinyl membrane. Gopher holes have been patched and eradication is now being used in the area.

The impervious lining makes a favorable environment for water grasses, cattails, and other water-loving plants. Those which have appeared in the lined area have been carefully removed and as yet disclose no punctures in the membrane.

In summary, it appears that the buried vinyl membrane lining is an effective tool in combatting seepage, with the advantages and reasonable costs far outweighing the disadvantages. The Arch Hurley Conservancy District plans to install additional reaches of lining of this type in the near future.

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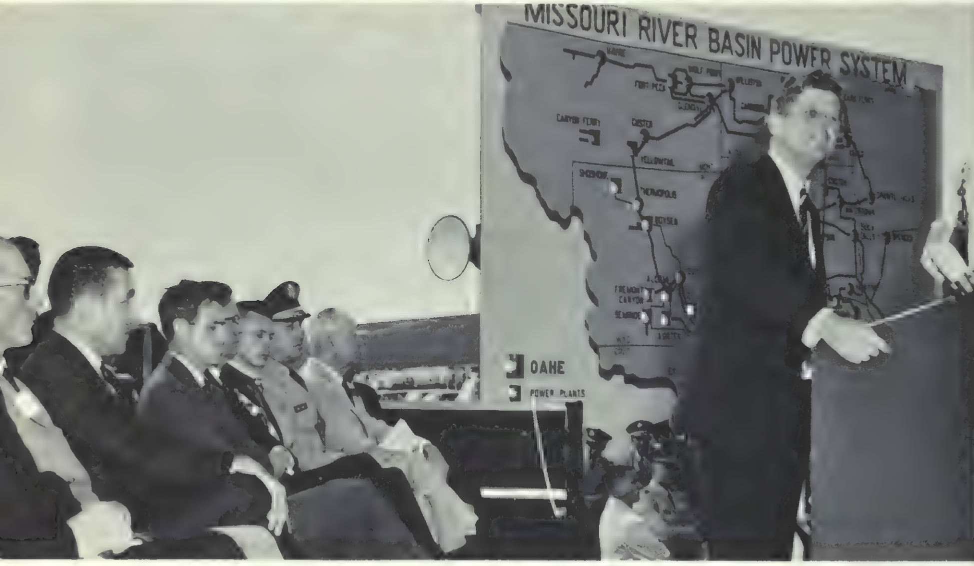
RECLAMATION MILESTONES... Preside



President John F. Ken
Reclamation and set a s
visiting three major pr

p Photos Oahe Dam ceremonies, Presi-
peaking. Left, Secretary Udall and As-
Secretary Holum seated with others on
platform.

Oahe Powerplant. Travelling by his silvery jet plane "Air Force No. One," the President landed first on August 17, at Pierre, S. Dak., where he addressed 8,000 people at the Oahe Dam and powerplant. The first energy from this Corps of Engineers project started flowing into the Bureau's Missouri River Basin power system a few months ago.

About MRB power, the President said: "The REA co-ops and power districts which have marketed this power have been a happy middle ground between private enterprise and public cooperation. They are making the most of Theodore Roosevelt's principle that marketing agencies which represent all the people should be given a preference in the development of waters which belong to all the people."

The final generating unit of Oahe powerplant is expected to go into production in April 1964.

Fryingpan-Arkansas Project. Fro
kota the President flew to Pueblo,
dressed a crowd of 15,000 at the
School stadium who heard the P
marks about the huge Frying
project which he had approved b
thorizing legislation the day previ

"This marks the 60th anniversar
lamation program initiated under
President Kennedy said, "and thi
first year in which the Congress ha
ized two projects of the magnitude
Arkansas and the San Juan-Cham
Projects of New Mexico. Surely
the most unusual projects in the ent

Fryingpan-Arkansas is a multip
mountain diversion development
which will control floods, retain
serve fish and wildlife, and provid

Left Center Sen. Carroll, Colo., gives President Kennedy frying-pan memento. *Left* Secretary Udall is speaking to the Pueblo gathering.

Kennedy's Visits

by FLOYD E. DOMINY, Commissioner, Bureau of Reclamation

lighted the 60th anniversary of the Bureau of milestone in Reclamation history by personally Bureau territory. . . .

"Needs . . . a broad new conservation effort."

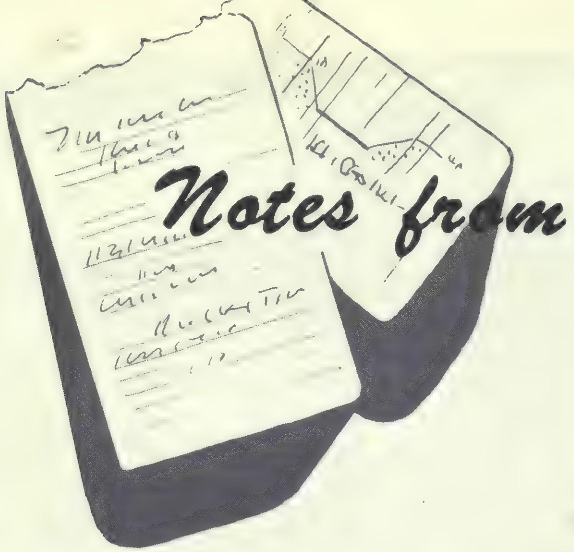
San Luis Unit. The following day, speaking before a crowd of 15,000 at the San Luis Damsite in the Central Valley in California, President Kennedy said, "This is a unique ceremony because this partnership is at the highest level (of State and Federal Governments). The amounts of contribution of both is unique and special, and the benefits that will come from it are unique and special, and I think that those who took part in this and made it possible should feel the strongest sense of pride."

The President and Governor Brown set off blasts marking the dam's intended location. President Kennedy also paid tribute to the struggle of many people who made possible the start of construction mentioning especially the late J. E. O'Neill, whose widow was awarded a certificate of commendation.

(*See another Reclamation Milestone on page 102.*)

Left **Commissioner Dominy and Mrs. O'Neill, widow of project backer, the late J. E. O'Neill, former President of Westlands District.**

President Kennedy and California's Governor Edmund Brown detonate blasts marking site for new dam.



Irrigation Operators' Workshop

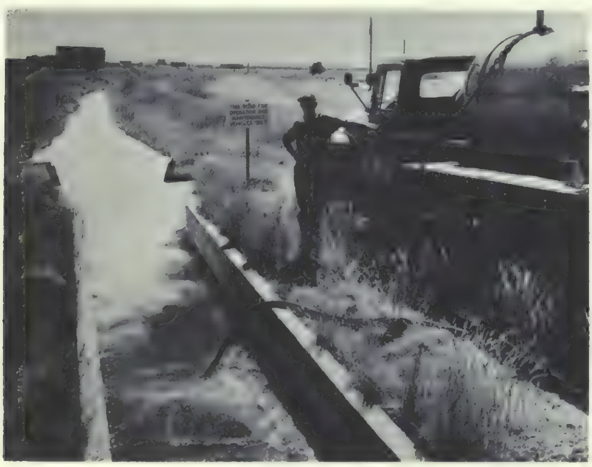
Part IV

The control of aquatic weeds and weed-control equipment were among the principal topics discussed by the 82 participants in the Irrigation Operators' Workshop at Denver last December. Leading the discussions of the workshop participants, who came from the 11 northern States of the Reclamation West, was Delbert D. Suggs, management agronomist, Columbia Basin project, Ephrata, Wash.

The following is a brief summary of the major topics highlighted by Mr. Suggs.

Aquatic weeds often occur on irrigation systems where they interfere with the quantity and quality of water delivered. Aquatic weeds collect in irrigation facilities such as trash racks, pumps, irrigation siphons, and sprinkler systems. They cause odors and otherwise detract from the water's usefulness. Such weeds include rooted flowering plants, algae, true moss, and pipe moss.

Applying aromatic solvent to control weeds in a Washington ditch.



Aquatic weeds may be controlled by chaining at frequent intervals. The removal and disposal of aquatic weeds is a particularly important part of the chaning method. Usually after aquatic weeds are torn lose from their roots in the soil; they then move downstream in the water and are collected on trash racks. These weeds may be diverted to one side into a sump or downstream into a main channel by the use of devices at each turnout.

Control of aquatic weeds by chemicals is a more recent development. Aromatic solvents at 8 to 10 gallons per cubic foot per second of flow have been effective 2 to 10 miles downstream. To be most effective, the solvent should contain more than 85 percent aromatics. If the solvent contains more than 0.2 percent water, an emulsion residue is likely to be formed, which prevents thorough mixing of the solvent with the irrigation water.

The kind and type and quality of additive employed to assist the solvent and irrigation water emulsification is critical. As little as 1 percent emulsifier added to the solvent prior to injection into the irrigation water has been effective in holding an emulsion 4 hours or longer.

Acrolein, a water-soluble material, has been developed by a petroleum company to kill weeds in flowing water. Satisfactory results have been obtained on reaches of canals 20 miles long after one application.

Although aromatic solvent and acrolein in high concentrations can cause damage to crops, concentrations now in use have been tested for crop damage and found safe. Treated water can be

applied directly to crops by normal irrigation practices. Water deliveries need not be interrupted.

Choice of aromatic solvent or acrolein on a particular project depends on two local conditions: the effectiveness of each material, and the comparative cost per cubic foot per second of channel capacity per mile of effective weed kill.

In weed control, commercial equipment must usually be modified to meet particular project needs. The following 10 rules are suggested in the "design" or modification of standard equipment for weed control use.

1. *Simplicity.* Equipment should not be a "plumber's nightmare"—no baling wire jungles, no spider web of cables.

2. *Sturdiness.* Equipment strength should be determined by the weed-control requirement and not by the weight of the equipment.

3. *Parts availability.* Readily available parts should be used wherever possible. Specially tooled parts should be held to the minimum. Only permanent joints should be welded.

4. *Weight.* The more equipment weighs the higher the original and operating costs. Accordingly, lightweight components should be used wherever possible.

5. *Speeds.* Engine speed and gear belt speeds should be set for maximum engine life, and speeds of the pump, truck, and agitator should be set for maximum efficiency.

6. *Pressure.* Full-size pipe and hose and full-flow valves should be used to minimize fluid pressure loss. There should be few fittings or short couplings. Lines should be straight or gently curved. Pressures should be kept low.

N. E. Otto (right) plant physiologist, explains an equatic weed test to participants: Carroll F. Wilcomb, Terrance A. Gulley, Tom Cotton.

Banks of this Columbia Basin project kept weedless by water tolerant redtop grass sod on waterline, crested wheatgrass on upper banks.

7. *Horsepower.* In considering equipment for pumping, it should be remembered that the power requirement varies directly with the pressure and that horsepower required to move 30 gallons of water per minute at 30 pounds per square inch is less than one-half of one horsepower. If a small amount of high-pressure, low-volume spraying is required, the purchase of two pumps should be considered rather than the purchase of a single high-pressure pump large enough to supply both high and low pressures and high and low volumes.

8. *Safety.* Equipment components should be arranged so that the operator's clothing will not become entangled with the moving parts of the equipment. Equipment should be cleaned daily. Safety equipment such as face shields, gloves, and respirators should be available as required. Fire-control equipment should be carried with weed burning equipment.

9. *Timing.* Spraying can be carried out most efficiently by proper timing—by providing rapid refilling of the sprayer tank, by providing adequate access to the areas to be sprayed, and by properly scheduling preventive maintenance of equipment.

10. *Maintenance.* A sprayer which is thoroughly checked and overhauled before the spraying season, and inspected and maintained daily during the season should require no major downtime during the spraying season. Grease, oil, dirt, and chemicals should not be permitted to accumulate on the sprayer. The rig should be washed down with a detergent in water after each day of spraying.

In planning a weed spray boom, the project needs should first be determined; then the type

of boom and actuating system best suited for the particular requirement should be selected. A weed spray boom is a device designed to put the herbicide spray droplets where they will do the most good—on the leaves of the weeds.

The nozzle is the most critical part of the spraying system. The orifice should be the largest which will deliver the desired quantity of liquid at the lowest pressure consistent with adequate coverage. The larger the orifice, the fewer problems with clogging. Each nozzle should be checked for output at least once each season.

After the nozzle, the pump is the most important part of the sprayer. Where growth-regulator type herbicides, such as 2,4–D are used, low pressures are mandatory to reduce drifting of the spray; therefore, centrifugal pumps are recommended. Centrifugal pumps which can provide pressures up to 40 pounds per square inch and deliveries of 30 gallons per minute can be purchased for about $60.

Weed-control equipment requires some type of access. The access available will dictate the general type of weed-control equipment. If there are reaches which have to be patrolled on foot, a three-wheel motor scooter may be useful as a spray vehicle. There are overgrown waterway "jungles" that cannot be penetrated even on foot. Heavy equipment used to clean these channels could provide a roadway at little extra cost the next time the channel is cleaned.

Only noxious weeds must be prevented on a

Shredder on Lower Rio Grande Rehabilitation Project, Texas, can mow either up or down on side slopes and it keeps clippings from water.

projectwide basis. However, it is important to recognize that certain weeds need not be completely controlled on all parts of the project. The same species which is giving trouble on one part of the project may be beneficial in another area.

For example, Russian thistle is a nuisance which may at times be beneficial temporarily, in helping to control erosion by wind and water until better plants can be established. Cattails may sometimes be retained to reduce beaching on large canals. Although tall fescue or reed canary grasses are highly detrimental on small channels, they may be highly beneficial on the larger channels of certain projects.

In this selective weed control evaluation, a plant is not an objectionable weed if it is worth more in place than whatever would replace it. The plant is not worth controlling as a weed if it would cost more to remove it than to leave it. # # #

(This concludes a four-part series which began in the February issue.)

RECLAMATION MILESTONES... Continued from page 99.

NAVAJO DAM. Dedication of Navajo Dam, the first such ceremony for any major feature of the Colorado River Storage project, was held September 15, with Secretary Stewart L. Udall giving the dedicatory address.

Water storage behind Navajo Dam on the San Juan River was underway in July and all construction in connection with the dam was scheduled to be completed by March 1963, having begun in July 1958. The dam is the second largest earth dam yet constructed by the Bureau, standing 388 feet above river bed and reaching 3,800 feet from one canyon wall to the other at crest. The reservoir will be 35 miles long with a total storage capacity of 1,709,000 acre-feet; and is planned to provide irrigation water for the 110,630-acre Navajo project by impounding floodwaters of the San Juan.

Also completed is 3.2 miles of access roadway and 1.5 miles of service roads. # # #

Drainage in Irrigation – a world problem

by C. R. MAIERHOFER, Chief, Bureau of Reclamation's Office of Drainage and Groundwater Engineering, Denver, Colo.

Editor's note—This article combined with the one entitled "Water Speaks Many Languages," beginning on page 106, will make interesting reading on water problems in some foreign croplands.

In this concluding article, Mr. Maierhofer, explains some of the steps taken in modern times to keep soil from becoming waterlogged and salinized. In the August issue of the Era, *the author outlined how lack of knowledge of irrigation helped bring the downfall of early civilizations.*

Part II

The first tile drains we know about for sure were built with horseshoe-shaped clay roofing tiles by the farmers of France during the 13th to 15th centuries. Then the French forgot how, and tile drains were not built in Europe again until the 17th or 18th century—this time in England.

America's first subsurface drains for agriculture were built by farmer John Johnston in New York State in 1835. Since about 1925, progress in handling drainage problems has been rapid in our irrigated lands, but land irrigated in the United States is only about 10 percent of the world's one-third billion irrigated acres, and the population of our country is a small part of the world's population that depends on irrigation and drainage to survive.

Even so, we have had and still have drainage problems and are not handling all of them as well as we could. Farmers of the western United States abandoned more than a million acres of irrigated land due to waterlogging and salinity at various times during the past 30 years.

As we learned about drainage, we reclaimed most of these lands, but even with today's bigness and richness, crop yields from our irrigated lands are still about 15 percent less than they should be, due to causes associated with inadequate drainage. Some of these lands are not producing half their potential. Nevertheless, our drainage record so far is good compared to most of the irrigated world.

Egypt gives us the documented history of the first nation that depended on irrigated agriculture, that saw it fail because of salt and seepage, then salvaged it by drainage—and survived. Surprisingly, the significant part of this history has happened within the past century.

As in other centers of great desert civilizations, irrigation started in the Nile Valley by annual flooding of low lands along the river. The flood occurred with unfailing regularity every autumn and put river levels 20 to 25 feet above summer levels.

The old records show that the higher the Nile during floods, the greater were the crops. Under Nature's scheme, the valley lands could not get

too much irrigation water. The annual flood was so important that the national economy was based on its height and duration. Then, as now, with prosperity came higher taxes.

Egypt's taxes were no exception. To keep the tax take in line with the prosperity, the tax rates were actually based, by royal decree, on the river levels at the Roda Gage of the Nile. There was official prosperity when the river reached a certain mark cut in the stone gage.

As man began to tamper with Nature's ways, and larger diversion structures came onto the Egyptian scene, irrigation became a year-round event, and serious drainage problems quickly developed. By the late 19th century, the rich lands of the Nile Valley were wet and salty, and Egyptians were starving.

British engineers, who were then handling Egypt's irrigation, decided that the cause was high ground water and that the cure was to lower it by building deep drains. The extensive drainage works they built in the last half century reclaimed much of the waterlogged and salted lands and now permit Egypt today to boast 4.5 million acres of some of the most productive irrigated land in the world. This was the earliest large-scale drainage project for irrigated lands.

In contrast to the history of successfully handling drainage problems in Egypt's Nile Valley, there are many millions of acres of waterlogged and salinized lands in the vast valleys of the Indus River system of India and Pakistan that got that way from irrigation and are daily getting worse.

As in Egypt, full-time engineered irrigation from large diversion structures was started on these lands in the late 19th and early 20th centuries. Famines are common there, and, although India has some other resources, the economy of Pakistan depends entirely upon its 23 million irrigated acres.

Ancient tilling and scant water work causes low crop yield.

Vast Central Asian acres undrained, salty; potentially reclaimable.

The story of the drainage problems is the same. Before modern diversion dams and large canals brought water to the lands throughout the year, the ground-water table was 70 to 100 feet below the surface. After full-time irrigation was initiated, many millions of acres of superior land became waterlogged, salinized, and totally unfit for crop production. One hundred thousand acres are going out of production annually.

Causes Of Salinization

When not enough water is put on the land at frequent enough intervals to satisfy the plant requirements, no excess water passes the plant root zone, and all of the salt brought to the lands by the irrigation water remains in the soil zone that must support plant growth.

When one recognizes that most irrigation waters contain from ½ to 3 or more tons of salt per acre-foot, and that desert irrigation requires from 4 to 10 acre-feet annually, it becomes terrifyingly evident that irrigation will completely and quickly salinize lands unless the salts are removed by pushing more water through the soil than the plant will use.

To intensify the salt and drainage problem, leakage from large canals fills the ground-water storage, bringing the water table near the surface. In many areas, the ground water is not high enough to harm plants by drowning them, but as the plants exhaust the deficient fresh water put on by irrigation, saline water moves up from the

ground-water table into the root zone and to the surface by capillary action.

In the absence of frequent and adequate irrigation, this movement of saline water to the surface, and its subsequent evaporation in the hot desert, continually deposit great quantities of salt on the surface of the land. So more millions of acres become barren and more people starve. This is the drainage problem that is steadily becoming worse instead of better in many desert countries of the world.

Decline and the Way to Recovery

The end came long ago to that part of ancient Persia which is now southern Afghanistan and southeastern Iran. Those people flourished when Alexander the Great came through around 400 B.C. Today there are vast barren plains which were once irrigated by means of very large still-visible canals and brush and stone diversion dams. There are ruins of buildings and palaces which show that millions of people once enjoyed a high level of civilization from these lands.

Today's evidence, and what little history there is, indicate that the lands became severly salted and waterlogged and that the consequent decrease in food production left the people so debilitated they were pushovers for the invading Mongols to sack in the 13th century A.D.

Although there is nothing there today—not a plant or an animal, only desolation—these vast ruined lands are potentially usable resources, and could be restored and again made productive through proper irrigation and drainage.

Centuries are not needed for such drainage and salinity problems to develop—they can happen overnight, so to speak. The King of Afghanistan built modern irrigation projects on some of his deserts less than 20 years ago, and made dependable, controlled water supplies available to the land.

As the canals and laterals were put to use by the people, large areas quickly became waterlogged and salinized, and farms and villages were abandoned. Soon after the lands began to suffer deterioration, enlightened and modern drainage relief was attempted, but little relief resulted, even though the drains were moderately efficient.

Here there were land, water, and drainage, but the project failed. The fourth ingredient—people—has been blamed for the failure, although some of the causes have been almost beyond man's control.

To those who take our knowledge of irrigation, drainage, soil science, and agronomy for granted, this points up again that there are problems greater than technical to be overcome if we are to help the hungry and unfortunate people of the world who need so much. The most challenging aspects of these problems are not technical or physical, but rather human.

Irrigation and drainage works can be brought to modern standards, and better methods and higher yields can be demonstrated, but the farmers may be satisfied with their primitive practices and productivity.

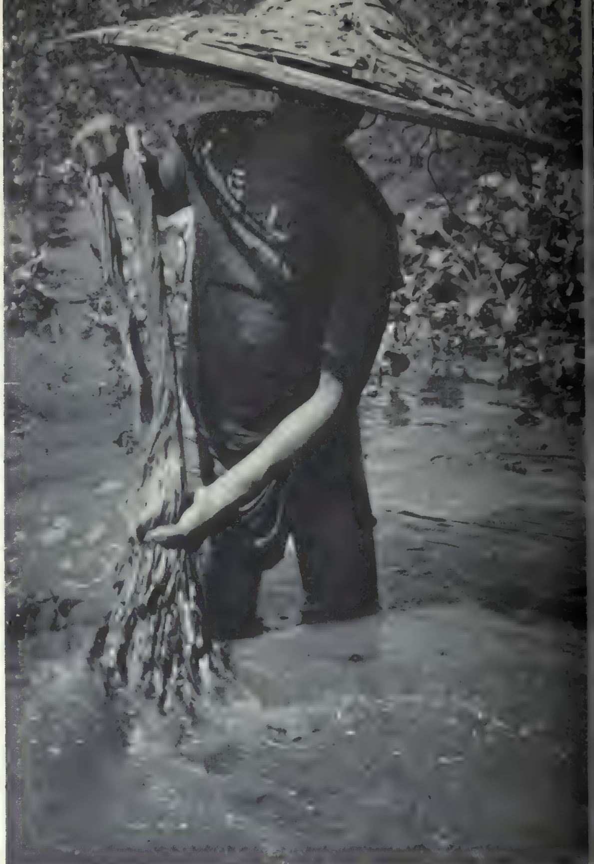
Thus, the drainage problems of much of the world are basically problems of people—sociological problems—how individuals and groups think and react and why. This his been as true in the Western United States as in the underdeveloped countries. Although it would be safe to say that most of our Western farmers know what drainage problems are and what to do about them, many still do not know or are doing little about them.

One thing is certain. As the population of the world swells, all people practicing irrigation will have to learn more about drainage. This will be necessary if the many millions of new people coming on the scene in the arid regions every year are to avoid the pattern of famine which has been stamped through the ages. # # #

With the Water Users

Judge J. E. Sturrock was awarded the *Willard J. Breidenthal Medal*, a National Rivers and Harbors Congress award, at their annual meeting, held in June in Washington, D.C. Judge Sturrock has, for many years, actively aided water conservation and irrigation law in Texas and in the Western States. At the present time he is general manager of the Texas Water Conservation Association, a position he has held since October 1944. Having long been active in writing laws and briefs, he has worked on a revision of the Texas water laws, on the negotiation of a treaty between the United States and Mexico, and other conservation and utilaztion programs. In the National Reclamation Association, Judge Sturrock has served as Texas director, as well as second vice president of the association. ★ ★ ★

WATER speaks Many Languages



by **PHIL HARDBERGER,**
Peace Corps
(Companion article can be found on page 103)

At first it seems difficult to understand. How is it that when two-thirds of the earth's surface is covered by water, there is a water shortage almost everywhere? The answer, as every Reclamation man knows, is that there is a lack of water control and a great deal of water is usable in its natural state.

The dust storms of the thirties brought the necessity of water control home to American farmers. But developing countries are just now realizing it, and beginning to take steps to remedy their situation. Many of these countries have called upon the Peace Corps for volunteers to help.

Peace Corps volunteer irrigation experts, agricultural extension workers, agronomists, land surveyors and canal operators are now serving in several countries including Brazil, Turkey, Pakistan, Cyprus, Bolivia, India, Iran, and Malaya.

East Pakistan illustrates the water problems that can beset a country. Over 90 percent of the 52 million people of East Pakistan are engaged in agriculture for a livelihood. With 1,000 persons per square mile, the country is one of the most densely populated areas in the world. As the population rate has continued to soar, agricultural methods have remained unchanged. There is a decreasing per-capita agricultural income, which simply means that more people are going to be starving in the future than have starved in the past unless something is done in a hurry.

The photograph on this page is one of the farmers washing his jute crop.

East Pakistani farmers are entirely dependent upon the monsoon rains for their crops. They grow only one crop a year. If the monsoon is irregular, a national disaster results. If the monsoon is delayed, the summer crops are destroyed by the drought. If the rains are heavier than usual, they are destroyed by flood. Far from being a sometimes event, the flooding destroys the crops on an average of once each 5 years. Thus, millions of people are dependent on the capricious whims of the monsoon.

Recognizing the problem, the Pakistani Government set up the Water and Power Development Authority under the guidance and technical advice of the Food and Agriculture Organization as a combination irrigation farming, drainage and flood control project. Twenty Peace Corps volunteers who had experience in water work were requested by the Pakistani Government to help with the project.

By using modern irrigation techniques, the Indian farmer who owns this field was able to put 33 acres of newly cleared land under cultivation. Peace Corps Volunteers are teaching conservation methods.

Volunteer supervising construction of s

Three goals have been set up by the WPDA: winter irrigation, so that crops can be grown in the dry winter months; timely summer irrigation to offset the effects of a delayed monsoon season; and drainage to control flooding during heavy monsoon seasons.

The first steps have now been taken. Irrigation water is being drawn from the Ganges River by means of a series of lift pumps, and a network of secondary and tertiary field and individual plot canals are being built to supply an area of 1.8 million acres in the Kushtia, Jessore and Khulna Districts of East Pakistan.

Peace Corps volunteers are not only helping to build the actual irrigation system, but they are teaching irrigation farming and drainage to the farmers via an extension service. Water management and improved agricultural methods are stressed by the volunteers. More than 40,000 farmers will need to be introduced to irrigation farming in the Kushtia area alone. As more farmers are educated to take advantage of the irrigation, there will need to be an increase of agricultural extension and agricultural support services, including fertilizers, insecticides and seeds. Rural roads and communications will need to be improved as agricultural production increases.

"In other phases of work, the Peace Corps volunteers sometimes work themselves out of a job. This is not likely to happen in water work," said Jim Gibson, Chief of Peace Corps' Division of Agricultural Affairs. "With this type of project, the more that is done, the more there will need to be done. Agricultural engineers, county agents, extension workers and people who are knowledgable in water work will be needed for a long time."

The East Pakistani project is illustrative, but not comprehensive of water work being done by Peace Corps volunteers:

—*In Tunisia*, the volunteers are assisting the government in preparing a plan for the development of the country's central region. They are also conducting training programs in soil and moisture conservation and cereal production under dry land conditions.

—*In Malaya*, Peace Corps, civil engineers are constructing canals, and reinforced concrete structures such as sluice-flood gates, flumes, and pumping stations. Peace Corps surveyors are surveying proposed sites for future irrigation projects.

—*In Iran*, irrigation specialists from the Peace Corps are demonstrating and teaching arid farming methods. Other Peace Corpsmen are teaching at the training centers for rural secondary school teachers and agricultural extension agents.

—*In India*, irrigation and conservation equipment and techniques are being taught to students at several agricultural colleges by Peace Corps members.

—*In Bolivia*, Peace Corps agricultural engineers with irrigation experience are demonstrating to farmers proper irrigation practices, soil conservation, erosion control, proper plowing techniques, and reforestation.

—*In Turkey*, Peace Corps volunteers with water experience are working with the Turkish Directorate of Soil Conservation and Farm Irrigation in surveying, mapping, drafting, checking on dam construction, supervising terracing, leveling, and planting. Volunteers will also demonstrate irrigation and conservation methods.

All Peace Corps volunteers are specifically trained for the job they will be doing in the host country. Once they are selected, they usually participate in a three-phase training program. The first part takes place at an American college or university. Customs, history, language and particular job training are emphasized.

The second phase of the training is in Puerto Rico and consists largely of general physical fitness training. The object of the training is to build the volunteer's confidence in his own ability. The third phase of the training is in the host country itself, where the volunteer has an opportunity to gather his personal impressions of the country.

A college degree is not required for all of the positions, if the volunteer has had prior practical experience. The minimum age is 18, but there is no maximum age.

Volunteers receive a living allowance that covers food, clothing, housing, medical needs and miscellaneous expenses. In addition, each volunteer accrues $75 per month, which is banked for him in the United States until he completes his 2-year period of service. Volunteers also receive 30 days of leave a year.

Volunteer questionnaires may be obtained by writing to the Division of Agricultural Affairs, Peace Corps, Washington 25, D.C. Questionnaires are also available at most Post Offices and from county agricultural agents. # # #

WATER REPORT

by HOMER J. STOCKWELL, Staff Assistant, Water Supply Forecasting Unit, Soil Conservation Service, Portland, Oregon

The 1962 water year was characterized by adequate water supplies for almost all irrigated areas in western United States. As indicated from the mountain snowpack during the winter of 1961–62, streamflow ranged from slightly below average on the Columbia River and part of its tributaries to much above average on the Colorado, the Upper Rio Grande, and Interior Basin streams as well as the southern half of the Central Valley of California. Seasonal flow was also above average east of the Continental Divide in Wyoming and Colorado.

In general, the snowmelt season extended over a longer period than usual with relatively high temperatures and runoff during April followed by a cool May and June with snowmelt continuing late into July. Peak flows were low as compared to total runoff. Heavy local rains were common east of the Rocky Mountains in mid-summer.

The 1962 water year was also a turning point in water supply conditions in the West after 3 successive years of drouth. Water was available to meet normal demands with enough excess to restore severely depleted reservoirs to near normal carryover levels. An exception is along the Lower Rio Grande in New Mexico where irrigation demands were heavy in the late summer months. Storage in reservoirs in eastern Oregon remains low, as well as on some streams in southwestern Utah.

At High Elevations

Late summer and early fall precipitation has been deficient at high elevations with record low rainfall and runoff at some stations in Arizona and New Mexico. Mountain as well as valley soils tend to be dry particularly along the Continental Divide. Snowpack during the winter months will have to be at least average to assure a generally adequate water supply for 1963.

Water users will have reports available on the mountain snow accumulation to date and streamflow forecasts starting on January 1 in most Western States. Snow surveys are made monthly through May 1 and in a few locations to June 1. State and local watershed snow reports are available from State offices of the Soil Conservation Service in each State or from State water agencies. A west-wide water supply outlook report will be available monthly from the Water Supply Forecasting Unit, Soil Conservation Service, P.O. Box 4170, Portland 8, Oreg.

This report for the *RECLAMATION ERA* is prepared under the direction of R. A. Work, Head, Water Supply Forecasting Unit, Soil Con-

servation Service, and is based on information supplied by snow survey supervisors of the Soil Conservation Service and the California Department of Water Resources.

In the following paragraphs, water conditions during the 1962 season are briefly reviewed with emphasis on such factors as are now known that affect the outlook for 1963.

Arizona

Water supplies have been adequate in the principal irrigated areas of Arizona this year as a result of heavy runoff during the spring months.

The Salt River project reservoirs still contain much above average water supply. A substantial carryover storage will be available for 1963. Supplemental pumping continued to be required on the San Carlos project, and no carryover storage is anticipated for San Carlos Reservoir.

Summer precipitation and runoff has been much below average. The flow of the Salt River during August was the lowest in 49 years of record. Pumping has been required in the higher valleys which have limited storage capacity.

California

The California Department of Water Resources, coordinating agency for the California Cooperative Snow Survey program, reports that water conditions in California during the 1962 water year were generally good—a condition which was a great improvement over the previous 3 years which ranked with the lowest of record for the

*The Soil Conservation Service coordinates snow surveys during the winter and spring months conducted by its staff and many cooperators, including the Bureau of Reclamation, Forest Service, Geological Survey, other Federal agencies, various departments of the several States, irrigation districts, power companies, and others. The California Department of Water Resources, which conducts snow surveys in that State, contributed information on California water supply as a part of this report. The Water Rights Branch, British Columbia Department of Lands and Forests has charge of snow surveys in that province.

southern half of the State. The shortages caused by the prolonged period of drouth have been alleviated to varying degrees in most of the critically deficient areas.

Although 1962 must be classed as a good water year for California as a whole, it should be noted that monthly precipitation totals were above normal only in the months of November, February, and March. The San Joaquin Valley area was the only major hydrographic area of the State experiencing above normal runoff. Total runoff in the northern half of the State was considerably below average, although still more than adequate to meet most local needs. While considerable improvements in overall water supplies were noted throughout the central coastal area, the drouth continued unabated in the critical south coastal regions south of Los Angeles where the populace is almost completely dependent on imported water supplies.

Colorado

Water supplies were adequate for most irrigated areas of Colorado during the 1962 season. Streamflow from snowmelt extended through July. Demands were high during July and August with above average temperatures and deficient precipitation. Reservoir storage for the major irrigated areas was sufficient to meet the needs in late season but withdrawals were relatively high. However, carryover storage on the South Platte remains above average for the South Platte, 140 percent of average for the Colorado-Big Thompson system.

An even greater demand was made on storage in the Arkansas Valley. Carryover storage is below normal. John Martin Reservoir is empty.

The flow of the Colorado River and its tributaries west of the Continental Divide was much above average and generally in excess of needs even in late season. Water supplies were also good in San Luis Valley.

Below normal summer precipitation has left the mountain and valley soils extremely dry. At least an average snowpack next winter will be required to provide adequate water next year. Unless above average fall precipitation occurs, much of the snowpack will be needed to replace this soil moisture deficit.

Idaho

The 1962 irrigation season in Idaho was consistently good throughout the State. Many rivers with low carryover storage from 1961 now have average or better carryover, plus having a good season this year. The wells which were drilled during the dry year of 1961 have added some permanent water for late season irrigation which is needed in most years on rivers without adequate storage facilities.

The growing season was unusually cool and, so far into the fall, have been dry. Soils throughout the entire State are dry for this time of the year. There is a possibility that the month of October will bring soil moisture conditions up before permanent snow falls.

Irrigators using forecasts as a guide to their operations made excellent use of the normal water supplies for 1962. They increased their acreages significantly and were able to mature crops on a greater acreage than was possible in 1961.

Average or slightly better carryover storage on the principle irrigation streams will be available for the 1963 season.

Kansas

The flow of the Arkansas has been above average during this irrigation season but demands have been high. Deficient precipitation has resulted in heavy pumping resulting in a decline in water level in shallow wells. Reservoir storage is depleted.

Montana

A good mountain snowpack, together with a cool summer and average to above average spring and summer precipitation, provided an adequate water supply for Montana. Only a few small areas, mostly in the north central portion of the State, experienced any shortages of irrigation water. Water users east of the Continental Di-

Editor Palmer Leaves Post

Violet Palmer, who has been editor of *The Reclamation Era* since November 1960, resigned from Government service on August 7, 1962, to return to her home in Houston, Tex., after working in the Washington office since 1958. Miss Palmer reports that now she is following her interests in independent writing and civic activity.

vide welcomed the change from last year when the water supply was inadequate.

Storage in irrigation reservoirs has been generally satisfactory throughout the season even though carryover storage from last year was below average. Carryover storage this year is average or above average for the majority of irrigation reservoirs in the State.

Storage in power reservoirs is good for this time of year and will probably improve if average fall precipitation occurs.

Nebraska

With well above average flow in the North Platte in Wyoming, water supply in western Nebraska has been adequate this year. Midsummer rainfall was high but late summer precipitation was deficient. Carryover storage has improved substantially over that of a year ago.

Nevada

Irrigation water supply was adequate for most needs in 1962. The storms of February 1962 brought the deficient mountain snowpack to above normal and also produced immediate runoff into the principal reservoirs. By March 1, 1962, these reservoirs had gained 137,000 acre-feet of stored water. This brought the stored water supply up to 210,000 acre-feet compared to 73,000 acre-feet on February 1.

Total summer streamflow ranged 125 percent of average on the Humboldt River to 100 percent of average on east slope of Sierra streams. Reservoir storage, except for Lake Tahoe, is above average. Lake Tahoe, due to its large capacity was the last reservoir in the State to fall to dead storage level during the recent drouth. Likewise, it will require more than one normal year for Lake Tahoe to be returned to its usual operating level.

Soil moisture conditions in valley areas are relatively good.

New Mexico

Streamflow along the Rio Grande varied from above average in San Luis Valley and to the Middle Rio Grande District but below average for southern New Mexico. Much below average summer precipitation and a moderate degree of pumping has left the mountain and valley soils dry and the underground reservoir at near record lows. If these soils are not recharged by heavy fall rains, the runoff from next winter's snowpack will be reduced by this soil moisture deficit. Storage in Elephant Butte and Caballo Reservoirs is above last year but only 38 percent of average.

Water supply along the Canadian and Pecos Rivers was good this past year. Storage in Conchas and Alamagordo Reservoirs remains above average for this date but below that of a year ago.

Oklahoma

Streamflow was near average during the 1962 irrigation season but below average in late summer. Storage in Altus Reservoir will provide a good start for the 1963 season.

Oregon

The 1962 irrigation season in Oregon has generally been an improvement over the previous

United States Department of the Interior

Stewart L. Udall, Secretary

Bureau of Reclamation, Floyd E. Dominy, Commissioner

Washington Office: United States Department of the Interior, Bureau of Reclamation, Washington 25, D.C.

Commissioner's Staff

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Assistant Commissioner	W. I. Palmer
Assistant Commissioner	W. Darlington Denit
Assistant Commissioner and Chief Engineer, Denver, Colorado	Grant Bloodgood

REGIONAL OFFICES

REGION 1: Harold T. Nelson, Regional Director, Box 937, Reclamation Building, Fairgrounds, Boise, Idaho.
REGION 2: Hugh P. Dugan, Regional Director, Box 2511, Fulton and Marconi Avenues, Sacramento 11, Calif.
REGION 3: A. B. West, Regional Director, Administration Building, Boulder City, Nev.
REGION 4: Frank M. Clinton, Regional Director, 32 Exchange Place, P.O. Box 360, Salt Lake City 10, Utah.
REGION 5: Leon W. Hill, Regional Director, P.O. Box 1609, Old Post Office Building, 7th and Taylor, Amarillo, Tex.
REGION 6: Bruce Johnson, Regional Director, 7th and Central, P.O. Box 2553, Billings, Mont.
REGION 7: ———, Regional Director, Building 46, Denver Federal Center, Denver, Colo.

three consecutive dry seasons ending in 1961. However, a few eastern Oregon areas were out of water in late August or September this year and reservoirs, in many areas, are now empty or at extremely low levels of storage—a fact which increases the possibility of another short season next year.

Much above normal fall rains to prime the "powder dry" watersheds are needed together with a heavier than normal snowpack this coming winter to bring water supplies up to normal.

Texas

Snowmelt runoff was below average in the Rio Grande serving West Texas and southern New Mexico, but water supplies were above most recent years. Summer precipitation was extremely deficient. Soils are dry and groundwater levels are at an all time low in the heavily pumped areas.

Utah

As anticipated last spring, water supplies for irrigation this summer have proven adequate for practically all areas of Utah. A prolonged summer drouth has caused some late season shortages in southwestern areas.

Holdover storage in reservoirs of northern Utah, while still below average in the larger ones is much better than a year ago. In the southern part of the State the reservoirs will have very little holdover water in 1963.

Because of the extended late summer dry weather, both mountain and irrigated soils are dry. Unless the weather pattern changes soon, the snow accumulation season will start with a soil water deficit that will have to be met from the snowpack.

MAJOR RECENT CONTRACT AWARDS

Specification No.	Project	Award date	Description of work or material	Contractor's name and address	Contract amount
DC-5752	Avondale, Dalton Gardens, and Hayden Lake Pipe Rehabilitation, Idaho.	July 5	Furnishing and laying 36 miles of pipelines and cleaning and painting two water tanks for Avondale, Dalton Gardens, and Hayden Lake distribution system.	Snelson Plumbing & Heating, Inc., Sedro Woolley, Wash.	$726,697
DS-5780	Colorado River Storage, Ariz.-Utah.	July 18	Nine 100,000-kva power transformers for Glen Canyon powerplant, Schedule 1.	McGraw-Edison Co., Pennsylvania Transformer Division Canonsburg, Pa.	1,093,790
DS-5780	Colorado River Storage, Ariz.-Utah.	July 18	Three 100,000-kva power transformers for Glen Canyon powerplant, Schedule 2.	Westinghouse Electric Corp., Denver, Colo.	332,893
DC-5797	Weber Basin, Utah	Sept. 10	Construction of 8 miles of the final stage of Willard canal	Strong Co., Springville, Utah	3,173,329
DC-5799	Missouri River Basin, Nebr.	July 26	Construction of 16 miles of Farwell Central canal and 27 miles of Farwell Central laterals C-4.8 to C-17.9, inclusive, wasteway and drains.	Bushman Construction Co., St. Joseph, Mo.	1,195,033
DC-5800	Missouri River Basin, Kans.	Sept. 4	Construction of Norton Dam	Van Buskirk Construction Co. and Graves Construction Co., Inc., Sioux City, Iowa.	5,579,026
DC-5803	Weber Basin, Utah	July 24	Construction of Layton pumping plant and appurtenant works.	Sylon-Reid Co., Ogden, Utah.	441,455
DC-5804	Rio Grande, N. Mex	July 13	Construction of Garfield siphon, utilizing precast-concrete pipe in the siphon barrel and with removal of existing Garfield flume, Schedule 2.	Burn Construction Co., Inc., Las Cruces, N. Mex.	197,278
DC-5805	Columbia Basin, Wash	Aug. 8	Construction of Sagemoor pumping plant, discharge line, and Eltopia Branch canal, Sta. 1246+50 to 1249+50.	Lewis Hopkins Co., Pasco, Wash.	362,394
DC-5806	Uncompahgre, Colo	Aug. 7	Construction of M and D Diversion Dam	Colo. Macco, Inc., Grand Junction, Colo.	206,936
DC-5808	Colorado River Storage, Colo.	July 26	Construction of 115-kv switchyard "Y" and transformer area for Green Mountain powerplant.	Eagle Construction Corp., Loveland, Colo.	107,296
DC-5809	Missouri River Basin, S. Dak.	Aug. 9	Construction of additions and modifications to Wall substation	Tullar Power Construction, Inc., Seattle, Wash.	107,443
DS-5813	Central Valley, Calif	Sept. 24	Eleven 60-foot by 18-foot fixed-wheel gates for overflow weir and sluiceway at Red Bluff diversion dam.	Star Iron & Steel Co., Tacoma, Wash.	279,865
DS-5816	Colorado River Storage, Ariz.-Utah.	Aug. 24	Four 230-kv and four 34.5-kv power circuit breakers for Glen Canyon switchyard, Schedules 1 and 2.	Federal Pacific Electric Co., Santa Clara, Calif.	224,141
DC-5818	Central Valley, Calif	Aug. 7	Construction of roadway, culverts, and surfacing for 3 miles of temporary detour of California State Highway 152 at San Luis dam site.	Jesse H. Harrison, San Ardo, Calif.	287;267
DS-5820	Wichita, Kans	Aug. 31	Four 6-foot by 7-foot 6-inch high-pressure gate valves, four hydraulic hoists, and two gate hangers for river outlet works at Cheney Dam.	Filer & Stowell Co., Milwaukee, Wis.	114,607
DC-5821	Central Valley, Calif	Sept. 13	Construction of earthwork and structures for preconsolidation of San Luis canal, Sta. 1487+30 to 1760+00.	Wilmoth Construction Co., Fresno, Calif.	266,131
100C-554	Chief Joseph Dam, Wash.	Aug. 14	Completion of River and Booster pumping plants	R. J. McCarthy Co., Seattle, Wash.	127,980
200C-499	Central Valley, Calif	July 3	Construction of Las Flores Avenue and Ottman Avenue pumping plants.	Patterson Construction Co., Klamath Falls, Oreg.	192,023
602C-36	Missouri River Basin, S. Dak.	Sept. 13	Furnishing and applying buried asphaltic membrane lining for reaches of Angostura canal and laterals 1.9, 5.5, 5.5A and 10.6, Schedules 1 and 2.	Hicks Construction Co., Inc., Riverton, Wyo.	217,092
617C-71	Missouri River Basin, Wyo.	Sept. 10	Construction of earthwork and structures for 0.2 mile of open drain and 8.3 miles of pipe drains.	Holm-Sutherland Co., Inc., Billings, Mont.	158,344

Washington

Water supplies for the 1962 irrigation season in Washington were adequate. During the spring and early summer, the weather remained cool. Runoff was delayed and normal high spring flows did not materialize. Streamflow over the whole State remained fairly constant and irrigation demands were below normal.

Carryover storage of the water is good in all reservoirs except for the small reservoirs in Okanogan County. Soil moisture in early fall is far below what can normally be expected. Mountain soils are very dry along the Cascade Range and in the eastern parts of the State. Unless heavy fall rains occur, the soil mantle will go into the winter season dry and will take additional water from the melting snowpack next spring.

Wyoming

Water supplies in Wyoming were excellent for the 1962 season. Streamflow from snowmelt ranged generally from 125 to 150 percent of average. Heavy rainfall in the north-central and eastern parts of the State during June supplemented the snowmelt causing flood damage in local areas. Streamflow remained above average late in the irrigation season.

Storage in all major reservoirs increased substantially during the summer months. On the North Platte the increase was from less than 50 percent of average carryover for the 1962 season to near 200 percent of average for 1963. The outlook for 1963 in this area is good. As of early fall, mountain and valley soil moisture conditions are reported as near average.

# # #

Major Construction and Materials for Which Bids Will Be Requested Through November 1962*

Project	Description of work or material
Canadian River, Tex.	Constructing about 55 miles of 72- to 96-in.-diameter pipeline of precast-concrete pressure pipe for lower hydrostatic heads and either noncylinder prestressed concrete pipe, thick wall cylinder concrete pipe or prestressed cylinder concrete pipe for higher hydrostatic heads; one reservoir of about 44 acres bottom area with an 18-ft water depth; and four steel surge tanks from 18 to 25 ft in diameter from 130 to 190 ft high. Main Aqueduct, from Sanford Dam south to vicinity of Amarillo.
Central Valley, Calif.	Constructing San Luis Dam.
Do	Constructing about 15 miles of ditches. Constructing about 30 miles of from 10-54-in.-diameter pipelines, a concrete-lined reservoir, and two steel tanks.
Do	Constructing the Wintu Pumping Plant, an outdoor-type plant having a reinforced concrete substructure, furnishing and installing four motor-driven pumping units of 100-cfs total capacity, mechanical and electrical auxiliary equipment, mechanical fish-screen and steel manifold. Near Redding.
Colo. River Storage, Ariz.	Constructing concrete foundations and erecting four each of eight types of 230-kv, single-circuit, guyed and self-supporting, steel, aluminum and prestressed concrete towers. Glen Canyon-Shiprock Transmission Line, near Kayenta.
Do	Constructing the Pinnacle Peak Substation will consist of major items being Government furnished. Near Phoenix.
Do	Furnishing and installing one 2,000- and one 10,000-lb-capacity passenger elevators in Glen Canyon Powerplant and two 10,000-lb-capacity passenger elevators in Glen Canyon Dam.
Colo. River Storage, Colo.	Constructing the Curecanti Substation at Cimarron.
Colo. River Storage, N. Mex.	Furnishing and installing fence gates, clearing right-of-way, constructing concrete footings, and furnishing and erecting steel towers for about 25 miles of 230-kv, single-circuit Glen Canyon-Shiprock-Cortez-Four Corners (APS) Transmission Line. In the vicinity of Shiprock.
Do	One 100,000-kva, 230- to 115-kv, 3-phase autotransformer for Shiprock Substation.
Columbia Basin, Wash.	Earthwork and structures for about 4.5 miles of concrete-lined laterals with bottom widths varying from 5 to 3 ft, about 26 miles of earth-lined laterals with bottom widths varying from 16 to 2 ft, and about 4.5 miles of unlined wasteway channels. Block 17, near Eltopia.
Columbia Basin, Wash.	Earthwork and structures for about 4.3 miles of 8-ft bottom width concrete-lined Eltopia Canal, near Eltopia.
Lower Rio Grande Rehabilitation, Tex.	Constructing about 0.6 mile of new drain, enlarging about 0.9 mile of existing drain, and cleaning and reshaping about 2.8 miles of existing drain. La Feria 3.A, near La Feria.
MRBP, Colo	One 110- to 69- to 34.5-kv, 20,000-kva, 3-phase autotransformer.
MRBP, Iowa	Additions to the Denison Substation will consist of constructing concrete foundations, furnishing and erecting steel structures, and furnishing and installing two 161-kv circuit breakers and associated electrical equipment. At Denison.
MRBP, Mont	Two 125-ton-capacity, overhead traveling bridge cranes for Yellowtail Powerplant. Estimated weight: 280,000 lb.
MRBP, Nebr	Earthwork and structures for about 14 miles of 7-ft bottom width, concrete-lined Ainsworth Canal. Near Valentine.
Do	Earthwork and structures, Red Willow canals, laterals, and drains, near Indianola.
MRBP, N. Dak	One 230- to 115-kv, 33,333-kva, single-phase mobile autotransformer.
MRBP, S. Dak	Clearing right-of-way, constructing concrete footings, and furnishing and erecting steel towers. From Big Bend Powerplant to Fort Thompson Substation.
Do	Furnishing and constructing about 7 miles of 13.8-kv wood-pole Fort Thompson-Big Bend Transmission line. From Fort Thompson Substation to Big Bend Powerplant.
Norman, Okla	Four 6-ft 6-in. by 10-ft high-pressure gate valves complete with hoists and metal liners for Norman Dam. Estimated weight: 465,000 lb.
Seedskadee, Wyo.	Constructing the 87- by 60-ft Fontenelle Powerplant, a reinforced concrete substructure and intermediate structure with structural steel superstructure, metal wall panels and steel roof decking, to house one 16,000-hp reaction turbine operating under a 94-ft head at 150 rpm with a 10,000-kw generator.
Weber Basin, Utah.	Earthwork and structures for about 8.7 miles of 10-ft bottom width Layton Canal, part of which will be earth-lined, and about 9.5 miles of open ditch drains and relocated ditches. Near Ogden.

*Subject to change.

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